www.sautercar.com
Partner für Produktentwicklungen

ISO 27001+ ISO 9001 zertifiziert

Hauptstrasse 39 · CH - 4145 **Gempen** · **Switzerland** · Tel.: + 41 (0)61 / 703 17 77 · Fax: + 41 (0)61 / 703 17 79 · sauter@sautercar.ch
Rudolf- Diesel- Str. 23 · D – 71154 **Nufringen** · **Germany** · Tel.: + 49 (0)7032 / 913- 967 · Fax: + 49 (0)7032 / 913- 689 · info@sautercar.de

Sauter
Engineering + Design

FDM	ABS- M30	ABS- M30i	ABS-ESD7	ASA	Nylon6	Nylon12	Nylon 12 CB	PC	PC-ISO	PC-ABS	ST130	ULTEM 1010	ULTEM 9085	Antero	ABS-CF10	DIRAN 410 MF07 PA6	TPU 92A
Zugfestigkeit (Höchstwert)	XZ: 4,470 psi (30.8 MPa) ZX: 3,990 psi (27.5 Mpa	XZ: 4,650 psi (36 MPa)	XZ: 5,130 psi (35.4 MPa) ZX: 3,920 psi (27.0 MPa)	XZ: 4,750 psi (32.8 MPa) ZX: 4,110 psi (28.3 MPa)	Z: 9,800 psi (67.6 MPa) ZX: 5,300 psi (36.5 MPa)	XZ: 7,140 psi (49.3 MPa) ZX: 6,060 psi (41.8 MPa)	XZ: 12,100 psi (83.5 MPa) ZX: 4,750 psi (32.7 Mpa	XZ: 8,390 psi (57.9 MPa) ZX: 5,150 psi (35.5 MPa)	XZ: 8,300 psi (57 MPa)	XZ: 5,300 psi (36.5 MPa) ZX: 3,760 psi (25.9 MPa)	-	XZ: 11,500 psi (79.2 MPa) ZX: 4,080 psi (28.2 Mpa	XZ: 10,000 psi (69.2 MPa) ZX: 5,710 psi (39.4 MPa)	XZ: 10,600 psi (73.0 MPa) XZ: 8,650 psi (59.7 MPa)	XZ: 5,465 psi (37.7 MPa) ZX: 3,100 psi (21.3 MPa)	XZ: 6,490 psi (44.8 MPa) ZX: 4,460 psi (30.7 MPa)	XY: 2,432 psi (16.8 MPa) XZ: 2,519 psi (17.4 MPa)
Bruchdehnung	XZ: 8.1% ZX: 1.8%	XZ: 4%	XZ: 3.40% XZ: 1.59%	XZ: 5.9% ZX: 1.8%	XZ: 38.0% ZX: 3.2%	XZ: 30.0% ZX: 6.5%	XZ: 2.4% ZX: 1.2%	XZ: 13,100 psi (90.0 MPa) ZX: 10,900 (75.0 MPa)	XZ: 4.0%	XZ: 4.7% ZX: 1.8%	-	XZ: 4.0% ZX: 1.1%	XZ: 5.4% ZX: 1.9%	XZ: 6.1% ZX: 2.3 %	XZ: 2.70% ZX: 1.49%	XZ: 12.0% ZX: 3.1%	XY: 552% XZ: 482%
Biegefestigkeit	XZ: 8,510 psi (58.7 MPa) ZX: 6,910 psi (47.7 Mpa	XZ: 8,800 psi (61 MPa)	XZ: 9,800 psi (67.5 MPa) XZ: 6,440 psi (44.3 MPa)	XZ: 8,930 psi (61.5 MPa) ZX: 7,390 psi (51.0 MPa)	XZ: 14,100 psi (97.2 MPa) ZX: 11,900 psi (82 MPa)	XZ: 8,190 psi (56.5 MPa) ZX: 7,900 psi (54.5 MPa)	XZ: 22,200 psi (153 MPa) ZX: 9,080 psi (62.4 Mpa	XZ: 13,100 psi (90.0 MPa) ZX: 10,900 (75.0 MPa)	XZ: 13,100 psi (90 MPa)	XZ: 8,970 psi (61.9 MPa) ZX: 6,700 psi (46.2 MPa)	-	XZ: 18,600 psi (128 MPa) ZX: 11,800 (81.6 Mpa	Z: 15,000 psi (104 MPa) ZX: 10,600 psi (73.1 MPa)	XZ: 19,800 psi (136 MPa) ZX: 15,400 psi (106 Mpa	Z: 10,000 psi (69.0 MPa) ZX: 4,240 psi (29.2 MP	Z: 8,690 psi (59.9 MPa) ZX: 6,770 psi (46.7 MPa)	-
IZOD Kerbschlag-zähigkeit	XZ: 1.89 ft-lb/in (101 J/m) ZX: 0.603 ft-lb/in (32.2 J/m)	XZ: 2.6 ft-lb/in (139 J/m)	XZ: 0.678 ft-lb/in (36.2 J/m) ZX: 0.384 ft-lb/in (20.5 J/m)	XZ: 0.808 ft-lb/in (43.1 J/m) ZX: 0.445 ft-lb/in (23.8 J/m)	XZ: 2.0 ft-lb/in. (106 J/m) ZX: 0.8 ft-lb/in. (43 J/m)	XZ: 2.58 ft-lb/in (138 J/m) ZX: 1.33 ft-lb/in (71.0 J/m)	XZ: 1.99 ft-lb/in (106 J/m) ZX: 0.45 ft-lb/in (24.0 J/m)	Z: 1.44 ft-lb/in (76.8 J/m) ZX: 0.503 ft-lb/in (26.9 J/m	XZ: 1.6 ft-lb/in. (86 J/m)	XZ: 4.52 ft-lb/in (241 J/m) ZX: 0.637 ft-lb/in (34.0 J/m)	-	XZ: 0.498 ft-lb/in (26.6 J/m) ZX: 0.407 ft-lb/in (21.7 J/m)	XZ: 1.66 ft-lb/in (88.5 J/m) ZX: 0.735 ft-lb/in (39.2 J/m)	XZ: 0.770 ft-lb/in (41.1 J/m) ZX: 0.623 ft-lb/in (33.3 J/m)	XZ: 0.962 ft-lb/in (51.4 J/m) ZX: 0.381 ft-lb/in (20.3 J/m)	XZ: 8.28 ft-lb/in (442 J/m) ZX: 0.502 ft-lb/in (26.8 J/m)	-
Wärmeform-beständig-keit bei 264 psi	99.9 °C	82 °C	101.4 °C	97.9 °C	93 °C	84.3 °C	153.7 °C	142.2 °C	126°C	102.9 °C		212.2 °C	172.9 °C	147.23 °C	99 °C	70 °C	-
Einzigartige Eigenschaften	-	Biokompatibel	Elektrostatisch ableitfähige (ESD) Eigenschaften	UV-beständig mit der hervorragenden Ästhetik der FDM-Materialien	Sehr hohe Stabilität und Widerstandsfähigkeit kombinier	Widerstandsfähig, hohe Bruchdehnung	FDM-Material mit der höchsten Biegefestigkeit	Fest (Zugfestigkeit)	-	Fest (Schlagfestigkeit)	Löslich für Sacrificial Tooling-Anwendungen	Hohe Temperaturbeständigkeit und gute Druckfestigkeit für Verbundwerkzeug	FST-Zertifikat (Flammenausbreitung, Rauch und Toxizität), ULTEM™ 9085 resin Aerospace verfügbar	Hohe Festigkeit, Temperatur- und Chemikalien beständigkeit, geringe Ausgasung	Kohlefaser-gefüllt 10 %	Glatte, geschmeidige Textur mit geringer Gleitreibung	Elastomer

Quelle: Stratasys

Material	Besondere Merkmale
Antero™ 800NA (Polyetherketon)	• Hohe Temperatur- und Chemikalienbeständigkeit • Geringe Ausgasung und hohe Formstabilität • Hervorragende Festigkeit, Widerstandsfähigkeit und Verschleißbeständigkeit
Antero 840CN03 (Polyetherketon)	• Hervorragende ESD-Eigenschaften (elektrostatisch ableitfähig) • Hohe Temperatur- und Chemikalienbeständigkeit • Geringe Ausgasung und hohe Formstabilität • Hervorragende Festigkeit, Widerstandsfähigkeit und Verschleißbeständigkeit
ULTEM™ 1010 resin (Polyetherimid)	• Höchste Temperaturbeständigkeit, chemische Beständigkeit und Zugfestigkeit • Hervorragende Festigkeit und Wärmestabilität
ULTEM™ 9085 resin (Polyetherimid)	• Hohe Temperaturbeständigkeit und chemische Beständigkeit, höchste Biegefestigkeit • Ideal für Anwendungen im Transportbereich, z. B. in Flugzeugen, Bussen, Zügen und Schiffen • Thermoplast mit FST-Zertifikat (Flammenausbreitung, Rauch und Toxizität)
PPSF (Polyphenylsulfon)	• Mechanisch herausragendes Material mit höchster Festigkeit • Ideal für Anwendungen in Umgebungen mit ätzenden Stoffen und hohen Temperaturen
ST-130™ (Sacrificial-Tooling)	• Speziell für hohle Verbundwerkstoffteile entwickelt • Schnelle und automatische Auflösung • Hohe Temperatur und Druckbeständigkeit (Autoklav)
FDM Nylon 6 (Polyamid 6)	• Vereint höhere Festigkeit und Widerstandsfähigkeit als andere Thermoplaste • Für langlebige Bauteile mit einer perfekten Oberfläche und hoher Bruchfestigkeit
FDM Nylon 12 (Polyamid 12)	• Das widerstandsfähigste Nylon-Material in der additiven Fertigung • Hervorragend für häufig genutzte Schnappverbindungen, Druckverschlüsse und ermüdungsfeste Anwendungen • Einfacher und sauberer Prozess – ohne Pulver
FDM Nylon 12CF (Polyamid 12 Karbonfaser)	• Karbonfaserverstärkter Thermoplast mit hervorragenden strukturellen Eigenschaften • Höchste Biegefestigkeit • Bestes Steifigkeits-/Gewichts-Verhältnis
PC (Polycarbonat)	• Das am häufigsten industriell eingesetzte Thermoplast mit hervorragenden mechanischen Eigenschaften und überragender Temperaturbeständigkeit • Präzise, langlebig und stabil für robuste Bauteile, Muster für die Metallbearbeitung und Verbundarbeiten • Ideal für anspruchsvolles Prototyping, Werkzeuge und Vorrichtungen
PC-ISO™ (Polycarbonat)	• Kann mittels Gammastrahlen oder Ethylenoxid (EO) sterilisiert werden • Optimal für Anwendungsbereiche, die eine hohe Festigkeit und Sterilisation erfordern
PC-ABS (Polycarbonat – Acrylnitril-Butadien-Styrol)	• Hervorragende mechanische Eigenschaften mit der Temperaturbeständigkeit von PC (Polycarbonat) • Hohe Detailgenauigkeit mit der ansprechenden Oberflächenbeschaffenheit von ABS • Automatisches Entfernen der löslichen Stützstruktur
ASA (Acrylnitril-Styrol-Acrylat)	• Für UV-beständige Bauteile mit der hervorragenden Ästhetik der FDM-Materialien • Ideal für funktionales Prototyping im Außenbereich und kommerziellen Einsatz, sowie für Automobilteile und Zubehör-Prototypen
ABS-ESD7™ (Acrylnitril-Butadien-Styrol - statisch ableitfähig)	• Elektrostatisch ableitfähig mit einem Oberflächenwiderstand von 10^4-10^9 Ohm • Hervorragend geeignet für Montagewerkzeuge von elektronischen und statisch empfindlichen Produkten • Wird häufig für Funktionsprototypen von Gehäusen, Abdeckungen und Verpackungen verwendet
ABS-M30™ (Acrylnitril-Butadien-Styrol)	• Vielseitiges Material: Optimal für „form, fit and function"-Anwendungen geeignet • Bewährtes Produktionsmaterial für präzises Prototyping
ABS-CF10 (Acrylnitril-Butadien-Styrol - Karbonfaser)	• Robustes, steifes, mit Kohlefaser gefülltes Material für Vorrichtungen und andere Werkzeuganwendungen • Mehr als 50% steifer und 15% robuster als ABS-M30
Diran™ 410MF07	• Gute mechanische Eigenschaften und Widerstandsfähigkeit • Glatte Textur mit geringer Reibungsfläche • Bestens geeignet für die Herstellung von Betriebsmitteln, Vorrichtungen und Fertigungshilfsmitteln
PLA (Polylactid)	• Schneller Druck • Wirtschaftlich und benutzerfreundlich • Ideal für Konzeptmodelle
FDM™ TPU 92A (thermoplastisches Polyurethan)	• Elastomer-Material mit einem Shore-A-Kennwert von 92 • Flexibles, belastbares Material • Kompatibel mit löslicher Stützstruktur • Beschleunigt das Prototyping von Elastomeren ohne den Einsatz von Gussformen
ABS-M30i (Acrylnitril-Butadien-Styrol - biokompatibel)	• Robustes, biokompatibles, sterilisierbares Material, geeignet für den Einsatz in Medizinprodukten • Erfüllt die Testanforderungen von ISO 10993, USP Class VI und ISO 18562

Quelle: Stratasys

ASA

FDM Thermoplastic Filament

The information presented are typical values intended for reference and comparison purposes only.
They should not be used for design specifications or quality control purposes.

Overview

ASA (acrylonitrile styrene acrylate) FDM® filament is a broad-use commodity thermoplastic. It is similar to ABS (acrylonitrile butadiene styrene) but exhibits better UV resistance, mechanical properties and aesthetics than ABS.

ASA is suitable for most general-purpose 3D printing applications involving prototyping, jigs and fixtures and low-volume production parts. ASA filament is available in the most colors of any FDM material.

Contents:

Ordering Information 3
Physical Properties 5
Mechanical Properties 6
Appendix 10

Ordering Information

Table 1. Printer and Support Material Compatibility

Printer	Model Tip (Slice)	Support Material	Support Tip
F120™	F123 Head (7, 10, 13 slice)	SR-30 (soluble)	F123 Head (all slices)
F170™	F123 Head (5, 7, 10, 13 slice)	QSR Support™ (soluble)	F123 Head (all slices)
F270™	F123 Head (5, 7, 10, 13 slice)	QSR Support (soluble)	F123 Head (all slices)
F370™	F123 Head (5, 7, 10, 13 slice)	QSR Support (soluble)	F123 Head (all slices)
F770™	F123 Head (7, 10, 13 slice)	SR-30 (soluble)	F123 Head (all slices)
Fortus 450mc™	T10 (5 slice) T12 (7 slice) T16 (10 slice) T20 (13 slice)	SR-30 / 35 (soluble)	T12SR30 (all slices)
Fortus 900mc™/F900™	T10 (5 slice) T12 (7 slice) T16 (10 slice) T20 (13 slice) T40A (20 slice)	SR-30 / 35 (soluble)	T12SR30 (5, 7, 10, 13 slice) T20B (20 slice)

Build Sheet

F123 Standard Build Trays

Low Temperature

- 0.02 x 26 x 38 in. (0.51 x 660 x 965 mm)
- 0.02 x 16 x 18.5 in. (0.51 x 406 x 470 mm)

F770 Build Sheets

- 0.01 x 30 x 41 in. (0.254 x 762 x 1041 mm)

Colors

Black	Ivory
Red	Dark Blue
Dark Gray	Green
Light Gray	Yellow
White	Orange

Table 2. ASA Consumable Ordering Information

Part Number	Description
Printer Consumables	
511-10501	T10 tip, 0.005 in (0.127 mm) layer height
511-10301	T12 tip, 0.007 in (0.178 mm) layer height
511-10401	T16 tip, 0.010 in (0.254 mm) layer height
511-10701	T20 tip, 0.013 in (0.330 mm) layer height
511-10750	T40A tip, 0.020 in (0.508 mm) layer height
511-10900	T12SR30 support tip, 0.005-0.013 in layer heights
511-10710	T20B support tip, 0.020 in (0.508 mm) layer height
123-00401-S	F123 Extrusion Head, 0.005 - 0.013 in layer height
325-00300	Low Temperature build sheet, 0.02x26x38in (0.51x660x965mm)
325-00100	Low Temperature build sheet, 0.02x16x18.5 in (0.51x406x470 mm)
310-00100	Low Temperature build sheet, 0.03x16x18.5 in (0.76x406x470 mm)
355-00100	Low Temperature build sheet, 0.02x14x16.5 in (0.51x355x420 mm)
123-50100	F770 build sheet, 0.01 x 30 x 41 in. (0.254 x 762 x 1041 mm), box of 20
123-00302-S	F120/F170 Build Tray
123-00303	F270 Build Tray
123-00304	F370 Build Tray, Standard

Table 3. ASA Filament Ordering Information

Part Number	Description
Filament Canisters[1] [2]	
355-02140	ASA (Natural), 92.3 cu in. - Plus
355-02141	ASA (White), 92.3 cu in. - Plus
355-02142	ASA (Black), 92.3 cu in. - Plus
355-02143	ASA (Dark Gray), 92.3 cu in. - Plus
355-02144	ASA (Red), 92.3 cu in. - Plus
355-02145	ASA (Blue), 92.3 cu in. - Plus
355-02146	ASA (Light Gray), 92.3 cu in. - Plus
355-02147	ASA (Green), 92.3 cu in. - Plus
355-02148	ASA (Orange), 92.3 cu in. - Plus
355-02149	ASA (Yellow), 92.3 cu in. - Plus
360-50240	ASA (Natural), Xtend 500 - Plus
333-60500	ASA (Ivory), 60 cu in. - F123
333-60501	ASA (Black), 60 cu in. - F123
333-60502	ASA (White), 60 cu in. - F123
333-60503	ASA (Red), 60 cu in. - F123
333-60504	ASA (Blue), 60 cu in. - F123
333-60505	ASA (Green), 60 cu in. - F123
333-60506	ASA (Yellow), 60 cu in. - F123
333-60507	ASA (Orange), 60 cu in. - F123
333-60508	ASA (Dark Gray), 60 cu in. - F123
333-60509	ASA (Light Gray), 60 cu in. - F123
333-90500	ASA (Ivory), 90 cu in. - F123
333-90501	ASA (Black), 90 cu in. - F123
333-90502	ASA (White), 90 cu in. - F123
333-90509	ASA (Light Gray), 90 cu in. - F123
331-20507	ASA (Ivory), 200 cu in., long lead - F770
311-21000	ASA (Natural), 92.3 cu in. - Classic
311-21100	ASA (White), 92.3 cu in. - Classic
311-21200	ASA (Black), 92.3 cu in. - Classic
311-21300	ASA (Light Gray), 92.3 cu in. - Classic
311-21390	ASA (Red), 92.3 cu in. - Classic
311-21500	ASA (Blue), 92.3 cu in. - Classic
311-21600	ASA (Dark Gray), 92.3 cu in. - Classic
311-21700	ASA (Green), 92.3 cu in. - Classic
311-21800	ASA (Orange), 92.3 cu in. - Classic
311-21900	ASA (Yellow), 92.3 cu in. - Classic
355-03110	SR30 Soluble Support, 92.3 cu in. - Plus
360-53110	SR30 Soluble Support, Xtend 500 - Plus
311-30200	SR30 Soluble Support, 92.3 cu in. - Classic
355-03135	SR35 Soluble Support, 92.3 cu in. - Plus
311-30235	SR35 Soluble Support, 92.3 cu in. - Classic
333-63500	QSR Soluble Support, 60 cu in. - F123
331-20200	SR30 Soluble Support, 200 cu in - F120
331-20207	SR30 Soluble Support, 200 cu in., long lead - F770

[1] Classic canisters are compatible with all Fortus 900mc printers prior to s/n L502.
[2] Plus canisters are compatible with all Fortus 450mc, all Stratasys F900, and Fortus 900mc printers s/n L502 and up.

Physical Properties

Values are measured as printed. XY, XZ, and ZX orientations were tested. For full details refer to the Stratasys Materials Test Report (immediate download upon clicking the link). DSC and TMA curves can be found in the Appendix.

Table 4. ASA Physical Properties

Property	Test Method	Typical Values	
		XY	XZ/ZX
HDT @ 66 psi	ASTM D648 Method B	102.2 C (216.0 F)	
HDT @ 264 psi	ASTM D648 Method B	97.9 C (208.3 F)	
Tg	ASTM D7426 Inflection Point	103.55 C (218.39 F)	
Mean CTE	ASTM E831 (-50 °C to 90 °C)	69.38 µm/[m*°C] (38.54 µin/[in.*°F])	63.55 µm/[m*°C] 35.31 µin/[in*°F]
Volume Resistivity	ASTM D257	> 6.89*10^14 Ω*cm	
Dielectric Constant	ASTM D150 1 kHz test condition	3.14	4.74
Dielectric Constant	ASTM D150 2 MHz test condition	2.82	2.83
Dissipation Factor	ASTM D150 1 kHz test condition	0.009	0.009
Dissipation Factor	ASTM D150 2 MHz test condition	0.022	0.024
Thermal Conductivity*	ASTM E1952 @0C	0.1685 W/m*K 0.0974 BTU/(hr*ft*F)	
Thermal Conductivity*	ASTM E1952 @30C	0.1642 W/m*K 0.0949 BTU/(hr*ft*F)	
Thermal Conductivity*	ASTM E1952 @60C	0.1622 W/m*K 0.0937 BTU/(hr*ft*F)	
Thermal Conductivity*	ASTM E1952 @90C	0.1563 W/m*K 0.0903 BTU/(hr*ft*F)	
Thermal Diffusivity*	ASTM E1952 @0C	0.108 mm^2/s 1.67*10^-4 in^2/s	
Thermal Diffusivity*	ASTM E1952 @30C	0.096 mm^2/s 1.49*10^-4 in^2/s	
Thermal Diffusivity*	ASTM E1952 @60C	0.087 mm^2/s 1.35*10^-4 in^2/s	
Thermal Diffusivity*	ASTM E1952 @90C	0.077 mm^2/s 1.19*10^-4 in^2/s	
Specific Gravity	ASTM D257 @23 °C	1.08	

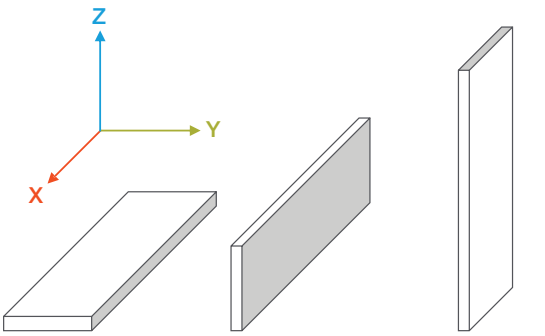
* Testing done on ASA - natural material

Mechanical Properties

ASA Black samples were printed with a 0.010 in. (0.254 mm) layer height on the F900 and F770. For the full test procedure please see Stratasys Materials Test Procedure (immediate download upon clicking the link).

Print Orientation

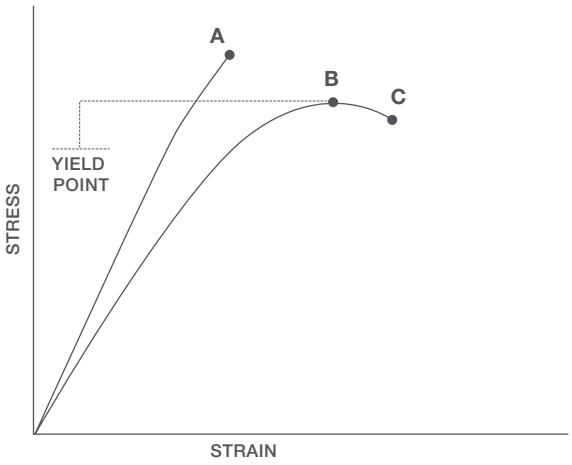
Parts created using FDM are anisotropic as a result of the printing process. Below is a reference of the different orientations used to characterize the material.



Flat (XY) On Edge (XZ) Upright (ZX)

Tensile Curves

Due to the anisotropic nature of FDM, tensile curves look different depending on orientation. Below is a guide of the two types of curves seen when printing tensile samples and what reported values mean.



A = Tensile at break, elongation at break (no yield point)
B = Tensile at yield, elongation at yield
C = Tensile at break, elongation at break

Table 5. ASA Black Mechanical Properties (F900 - T16 Tip)

		XZ Orientation[1]	ZX Orientation[1]
Tensile Properties: ASTM D638			
Yield Strength	MPa	32.8 (1.0)	No yield
	psi	4750 (150)	No yield
Elongation @ Yield	%	2.5 (0.085)	No yield
Strength @ Break	MPa	31.9 (0.98)	28.3 (2.1)
	psi	4630 (140)	4110 (310)
Elongation @ Break	%	5.9 (0.76)	1.8 (0.31)
Modulus (Elastic)	GPa	2.14 (0.072)	2.05 (0.20)
	ksi	311 (10)	298 (29)
Flexural Properties: ASTM D790, Procedure A			
Strength @ Break	MPa	No break	51.0 (1.4)
	psi	No break	7390 (200)
Strength @ 5% Strain	MPa	61.5 (1.1)	-
	psi	8930 (150)	-
Strain @ Break	%	No break	3.93 (0.25)
Modulus	GPa	1.98 (0.045)	1.76 (0.033)
	ksi	287 (6.5)	255 (4.8)
Compression Properties: ASTM D695			
Yield Strength	MPa	75.4 (3.8)	188 (28)
	psi	10900 (540)	27200 (4100)
Modulus	GPa	2.05 (0.060)	2.42 (0.26)
	ksi	297 (8.7)	351 (38)
Impact Properties: ASTM D256, ASTM D4812			
Notched	J/m	43.1 (3.8)	23.8 (3.8)
	ft*lb/in.	0.808 (0.071)	0.445 (0.052)
Unnotched	J/m	285 (61)	91.1 (18)
	ft*lb/in.	5.33 (1.1)	1.71 (0.34)

[1] Values in parentheses are standard deviations.

Table 6. ASA Black Mechanical Properties (F770)

		XZ Orientation[1]	ZX Orientation[1]
Tensile Properties: ASTM D638			
Yield Strength	Mpa	26.9 (1.4)	35.2 (0.37)
	psi	3910 (200)	5100 (53.9)
Elongation @ Yield	%	2.3 (0.4)	3.0 (0.08)
Strength @ Break	Mpa	27.0 (1.3)	33.7 (0.81)
	psi	3910 (190)	4900 (120)
Elongation @ Break	%	2.3 (0.4)	8.9 (1.5)
Modulus (Elastic)	GPa	1.62 (0.0186)	1.85 (0.0195)
	ksi	235 (2.70)	268 (2.83)
Flexural Properties: ASTM D790, Procedure A			
Strength @ Break	Mpa	No Break	48.2 (4.8)
	psi	No Break	6980 (700)
Strength @ 5% Strain	Mpa	60.6 (2.3)	-
	psi	9190 (340)	-
Strain @ Break	%	No Break	3.7 (0.7)
Modulus	GPa	1.90 (0.099)	1.72 (0.046)
	ksi	276 (14.3)	250 (6.67)
Impact Properties: ASTM D256, ASTM D4812			
Notched	J/m	60.9 (4.8)	28.5 (5.7)
	ft*lb/in	1.14 (0.091)	0.534 (0.11)
Unnotched	J/m	732 (140)	110 (22)
	ft*lb/in	13.7 (2.6)	2.07 (0.41)

[1] Values in parentheses are standard deviations.

Appendix

Figure 1. 2nd heating scan DSC data for the ASA Black Flat (XY) sample.

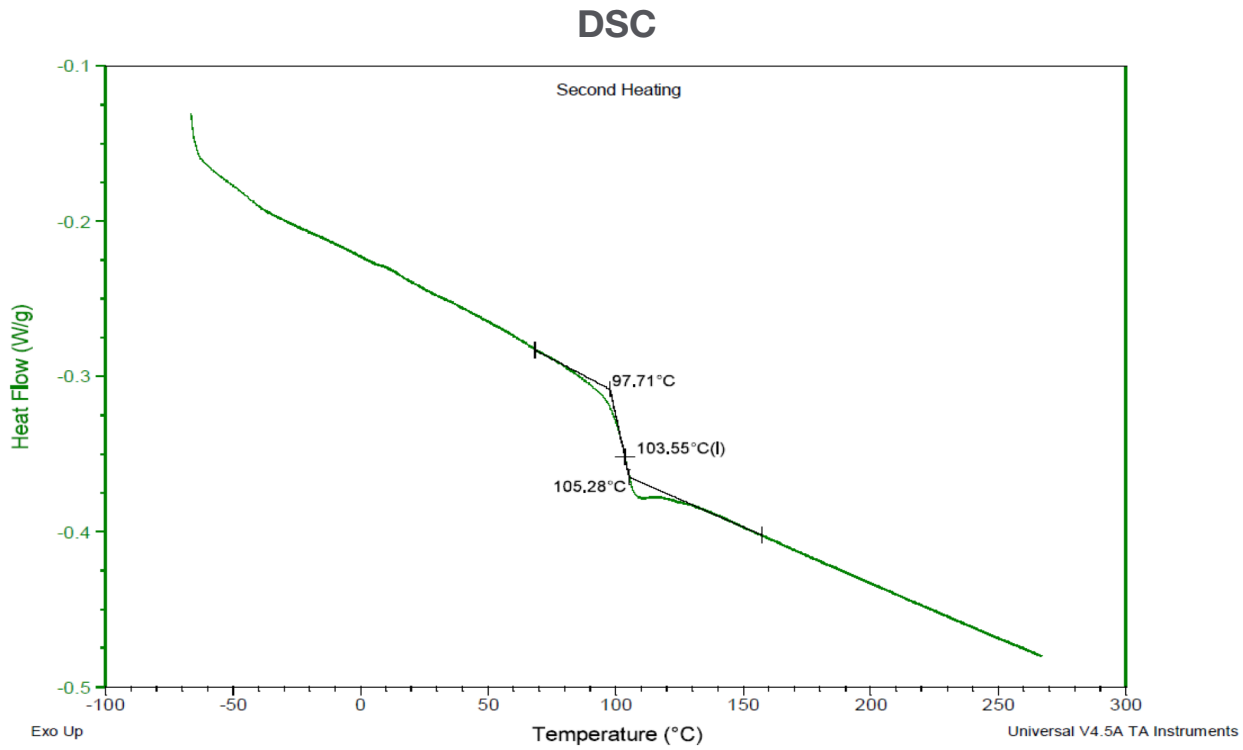


Figure 2. Dimension change data as a function of temperature for the ASA Black Flat (XY) sample.

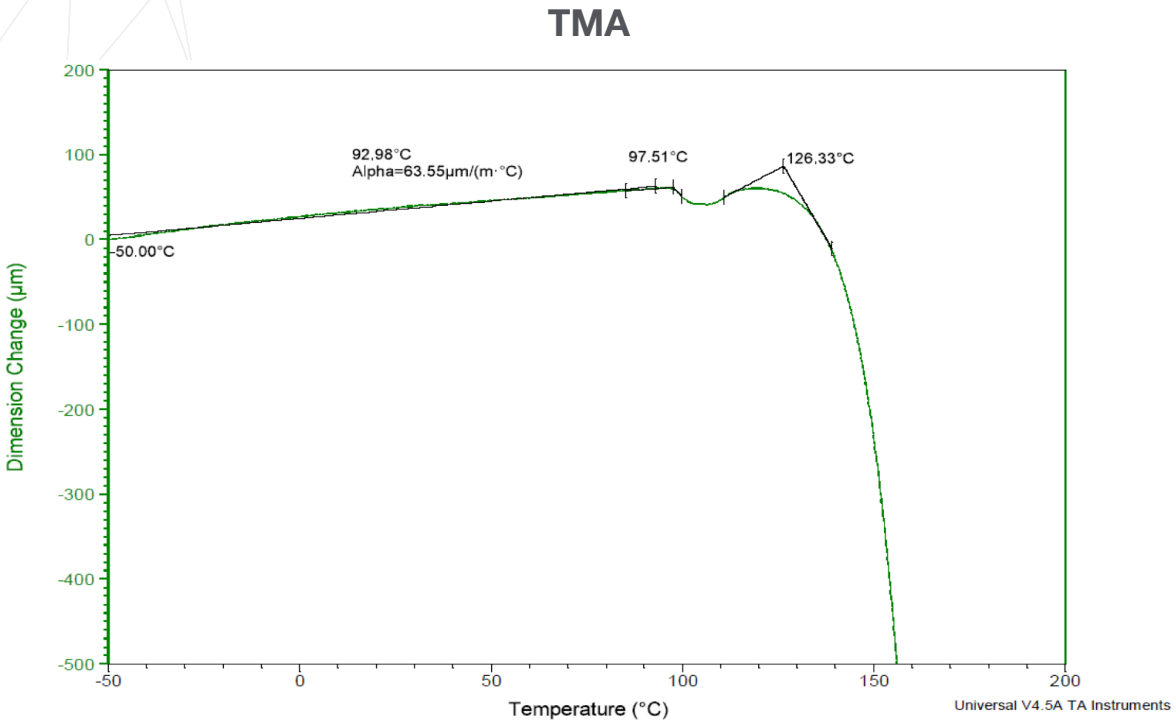


Figure 3. Dimension change data as a function of temperature for the ASA Black On Edge (XZ) sample.

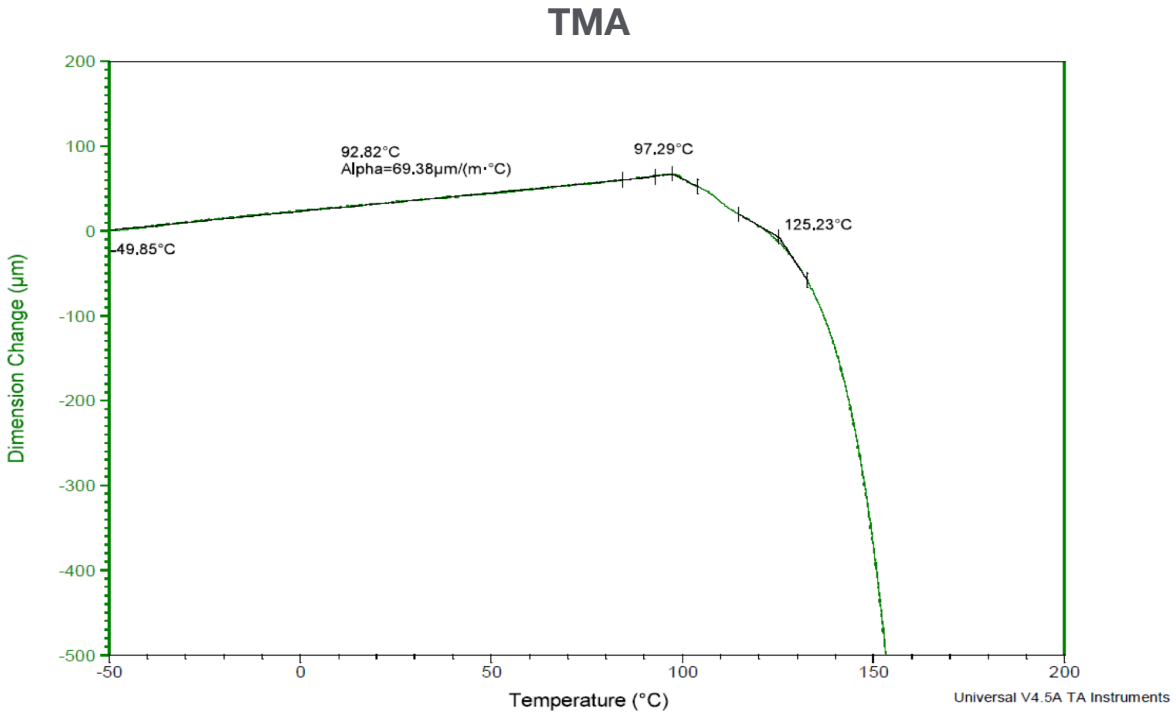
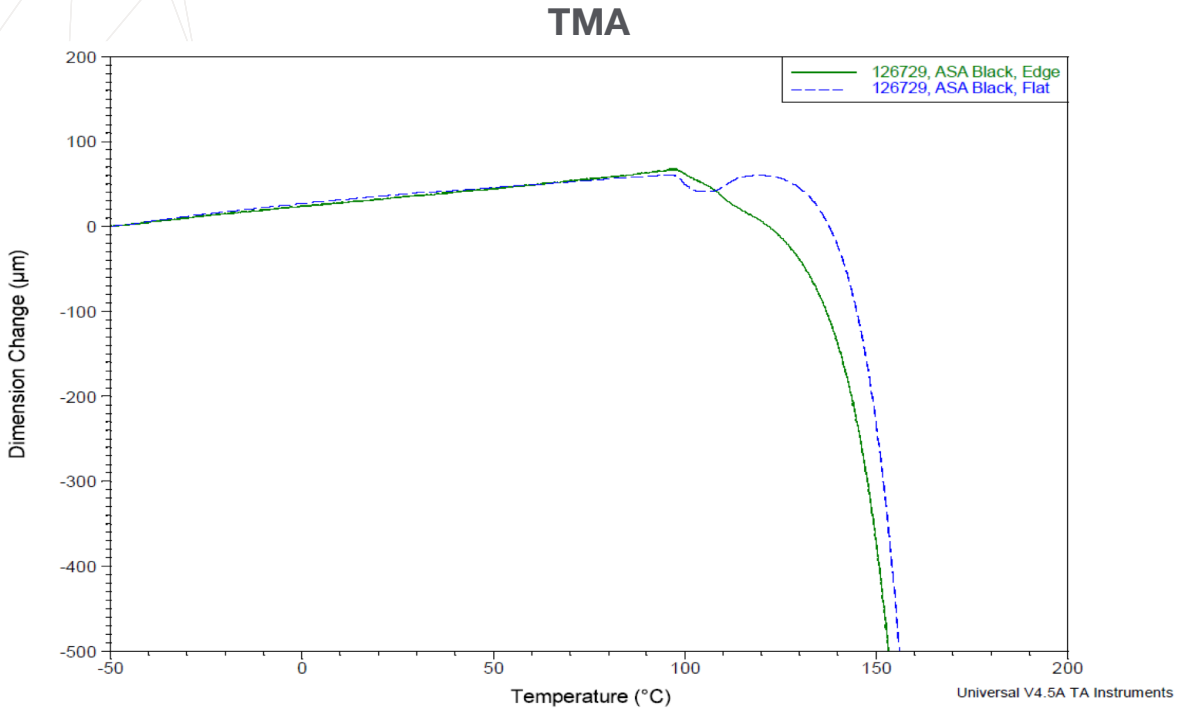


Figure 4. Overlay of the dimension change data for the Flat (XY) and On Edge (XZ) ASA Black samples.



Stratasys Headquarters

7665 Commerce Way,
Eden Prairie, MN 55344
+1 800 801 6491 (US Toll Free)
+1 952 937-3000 (Intl)
+1 952 937-0070 (Fax)

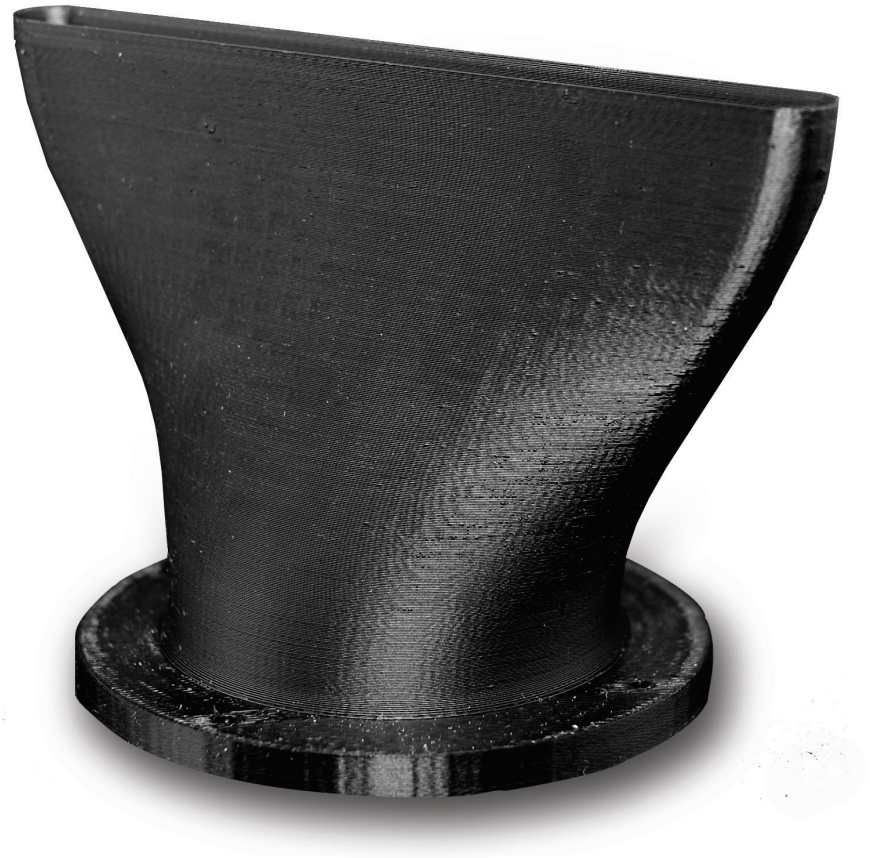
1 Holtzman St., Science Park,
PO Box 2496
Rehovot 76124, Israel
+972 74 745 4000
+972 74 745 5000 (Fax)

stratasys.com
ISO 9001:2015 Certified

PC-ABS

FDM Thermoplastic Filament

The information presented are typical values intended for reference and comparison purposes only.
They should not be used for design specifications or quality control purposes.



Overview

PC-ABS is a blend of polycarbonate (PC) and acrylonitrile butadiene styrene (ABS) thermoplastics. The result is an FDM filament that exhibits optimal characteristics of each – excellent strength, high toughness and heat resistance, and good flexural strength. Choose PC-ABS when you need the strength of PC but the impact resistance of ABS.

PC-ABS is suitable for a variety of applications that include prototyping, tooling and low-volume production. Available colors are black and white.

Contents:

Ordering Information 3
Physical Properties 5
Mechanical Properties 6
Appendix 8

Ordering Information

Table 1. Printer and Support Material Compatibility

Printer	Model Tip (Slice)	Support Material	Support Tip
F370™	F123 Head (5, 7, 10, 13 slice)	QSR Support (soluble)	F123 Head (all slices)
Fortus 450mc™	T10 (5 slice) T12 (7 slice) T16 (10 slice) T20 (13 slice)	SR-110™ (soluble)	T12SR100 (all slices)
Fortus 900mc™/F900™	T12 (7 slice) T16 (10 slice) T20 (13 slice)	SR-110 (soluble)	T12SR20 / 100 (all slices)

Build Sheet

Low Temperature

- 0.02 x 26 x 38 in. (0.51 x 660 x 965 mm)
- 0.02 x 16 x 18.5 in. (0.51 x 406 x 470 mm)

F123 Standard Build Trays

Table 2. PC-ABS Filament Ordering Information

Part Number	Description
Filament Canisters [1] [2]	
355-02260	PC-ABS (black), 92.3 cu in - Plus
310-20500	PC-ABS (black), 92.3 cu in - Classic
333-90701	PC-ABS (black), 90 cu in - F123
333-60701	PC-ABS (black), 60 cu in - F123
333-60700	PC-ABS (white), 60 cu in - F123
310-30500	SR-20 Soluble Support, 92.3 cu in - Classic
355-03130	SR-110 soluble support, 92.3 cu in - Plus
333-63500	QSR soluble support, 60 cu in - F123
Printer Consumables	
511-10501	T10 tip, 0.005 (0.127 mm) layer height
511-10301	T12 tip, 0.007 (0.178 mm) layer height
511-10401	T16 tip, 0.010 in. (0.254 mm) layer height
511-10701	T20 tip, 0.013 (0.330 mm) layer height
511-10901	T12SR20 tip, all layer heights
511-10100	T12SR100 tip, all layer heights
123-00401-S	F123 Standard Head (all layer heights)
325-00300[3]	Low Temperature build sheet, 0.02x26x38 in. (0.51x660x965 mm)
325-00100[4]	Low Temperature build sheet, 0.02x16x18.5 in (0.51x406x470 mm)
123-00304	F370 Build Tray, Standard

[1] Classic canisters are compatible with all Fortus 900mc printers prior to s/n L502.

[2] Plus canisters are compatible with all Fortus 450mc, all Stratasys F900, and Fortus 900mc printers s/n L502 and up.

[3] Compatible with Fortus 900mc and F900.

[4] Compatible with Fortus 450mc, Fortus 900mc and F900

Physical Properties

Values are measured as printed. XY, XZ, and ZX orientations were tested. For full details refer to the Stratasys Materials Test Report (immediate download upon clicking the link). DSC and TMA curves can be found in the Appendix.

Table 3. PC-ABS Physical Properties

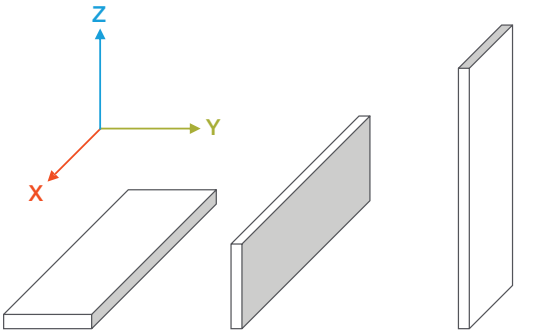
Property	Test Method	Typical Values	
		XY	XZ/ZX
HDT @ 66 psi	ASTM D648 Method B	125.0 °C (257.1 °F)	
HDT @ 264 psi	ASTM D648 Method B	102.9 °C (217.2 °F)	
Tg	ASTM D7426 Inflection Point	105.33 °C (221.59 °F)	
Mean CTE	ASTM E831 (-50 °C to 95 °C)	-	72.96 µm/[m*°C] (40.53 µin/[in*°F])
	ASTM E831 (-50 °C to 35 °C)	59.87 µm/[m*°C] (33.26 µin/[in*°F])	-
	ASTM E831 (35 °C to 50 °C)	0.4816 µm/[m*°C] (0.2676 µin/[in*°F])	-
	ASTM E831 (50 °C to 90 °C)	-61.76 µm/[m*°C] (-34.31 µin/[in*°F])	-
Volume Resistivity	ASTM D257	> 6.84*10^14 Ω*cm	
Dielectric Constant	ASTM D150 1 kHz test condition	2.62	2.74
	ASTM D150 2 MHz test condition	2.74	2.88
Dissipation Factor	ASTM D150 1 kHz test condition	0.001	0.002
	ASTM D150 2 MHz test condition	0.002	0.001
Specific Gravity	ASTM D257 @23 °C	1.10	

Mechanical Properties

PC-ABS samples were printed with 0.010 in. (0.254 mm) layer heights on the F900. For the full test procedure please see the Stratasys Materials Test Procedure (immediate download upon clicking the link).

Print Orientation

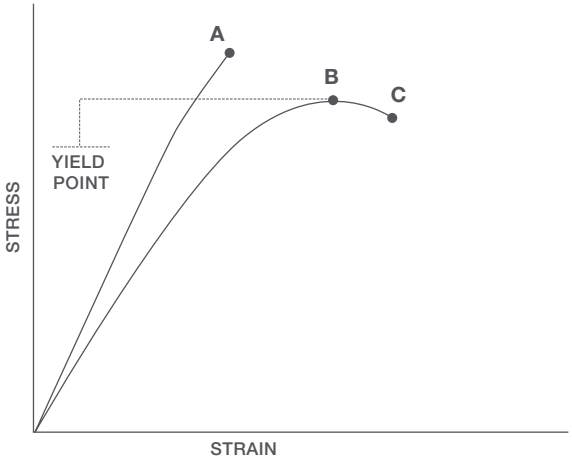
Parts created using FDM are anisotropic as a result of the printing process. Below is a reference of the different orientations used to characterize the material.



Flat (XY) On Edge (XZ) Upright (ZX)

Tensile Curves

Due to the anisotropic nature of FDM, tensile curves look different depending on orientation. Below is a guide of the two types of curves seen when printing tensile samples and what reported values mean.



A = Tensile at break, elongation at break (no yield point)
B = Tensile at yield, elongation at yield
C = Tensile at break, elongation at break

Table 4. PC-ABS Mechanical Properties (F900 - T16 Tip)

		XZ Orientation[1]	ZX Orientation[1]
Tensile Properties: ASTM D638			
Yield Strength	MPa	36.5 (0.73)	No yield
	psi	5300 (110)	No yield
Elongation @ Yield	%	3.0 (0.083)	No yield
Strength @ Break	MPa	34.7 (0.83)	25.9 (1.6)
	psi	5040 (120)	3760 (230)
Elongation @ Break	%	4.7 (0.75)	1.8 (0.22)
Modulus (Elastic)	GPa	1.99 (0.038)	1.87 (0.19)
	ksi	288 (5.5)	270 (27)
Flexural Properties: ASTM D790, Procedure A			
Strength @ Break	MPa	No break	46.2 (2.0)
	psi	No break	6700 (290)
Strength @ 5% Strain	MPa	61.9 (1.2)	-
	psi	8970 (170)	-
Strain @ Break	%	No break	3.51 (0.30)
Modulus	GPa	1.86 (0.14)	1.68 (0.069)
	ksi	269 (20)	244 (10)
Compression Properties: ASTM D695			
Yield Strength	MPa	96.5 (3.6)	172 (13)
	psi	14000 (530)	25000 (1900)
Modulus	GPa	2.14 (0.19)	1.85 (0.050)
	ksi	310 (27)	269 (7.3)
Impact Properties: ASTM D256, ASTM D4812			
Notched	J/m	241 (40)	34.0 (6.0)
	ft*lb/in.	4.52 (0.75)	0.637 (0.11)
Unnotched	J/m	655 (127)	101 (23)
	ft*lb/in.	12.3 (2.4)	1.89 (0.43)

[1] Values in parentheses are standard deviations.

Appendix

Figure 1. 2nd heating scan DSC data for the PC-ABS Flat (XY) sample.

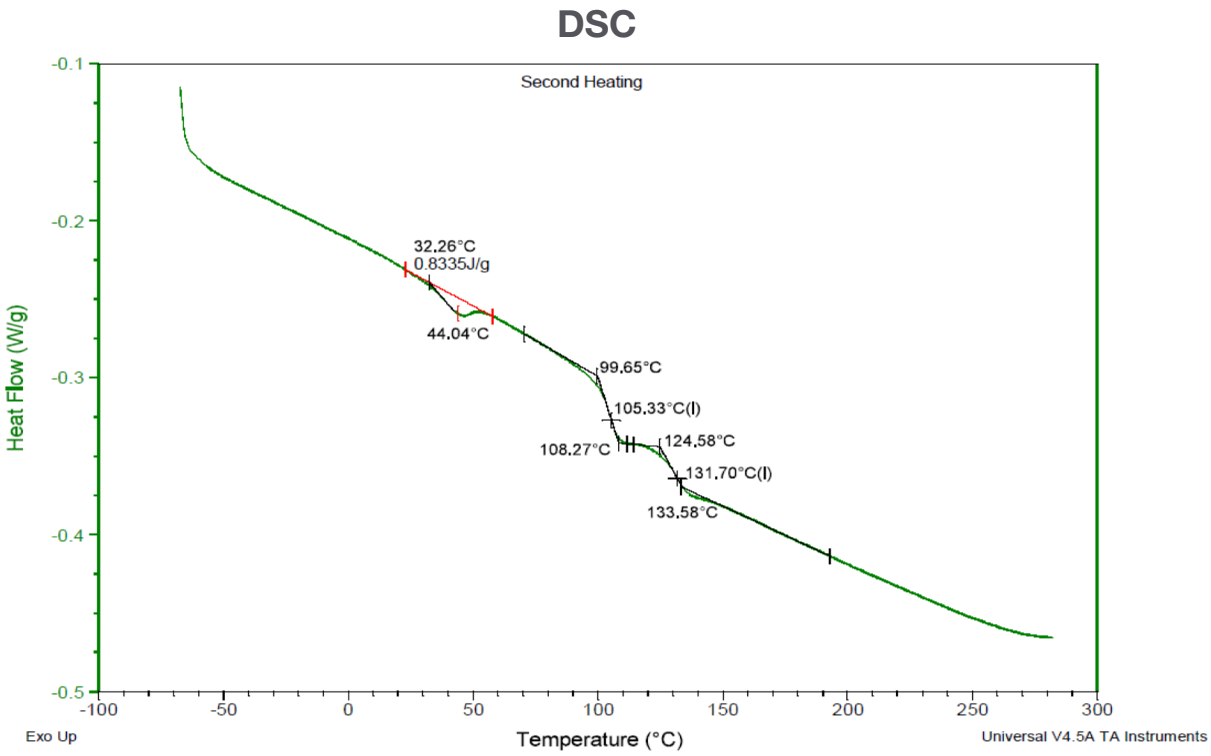


Figure 2. Dimension change data as a function of temperature for the PC-ABS Flat (XY) sample.

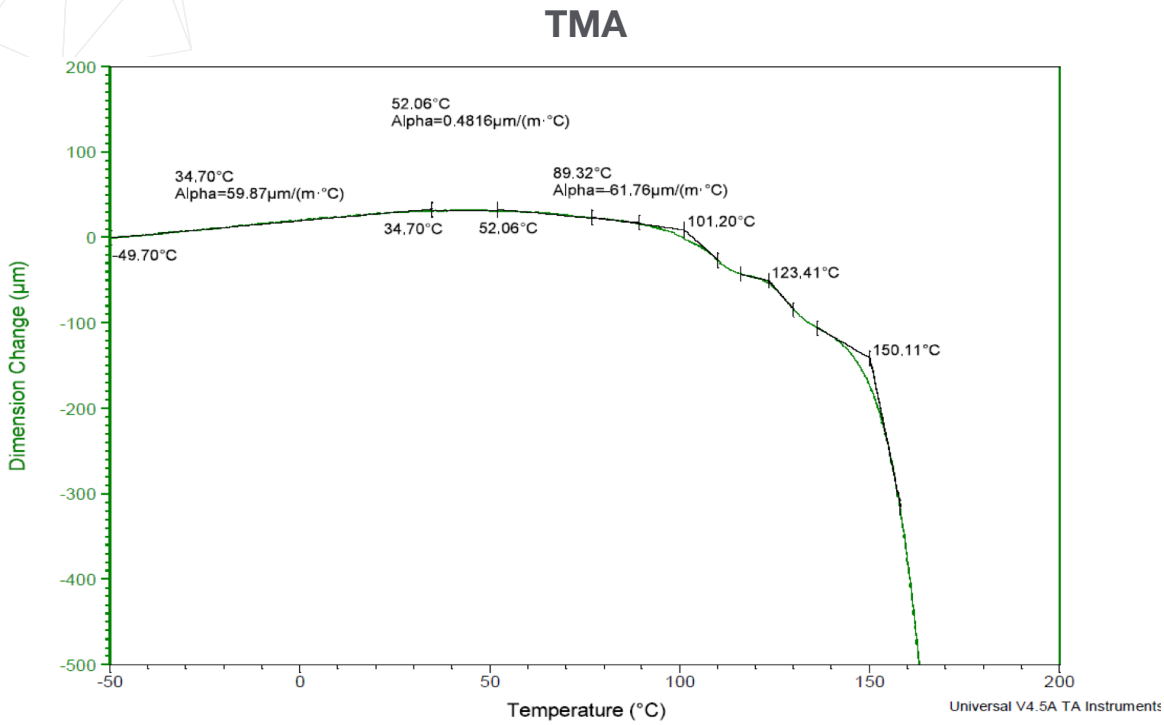


Figure 3. Dimension change data as a function of temperature for the PC-ABS On Edge (XZ) sample.

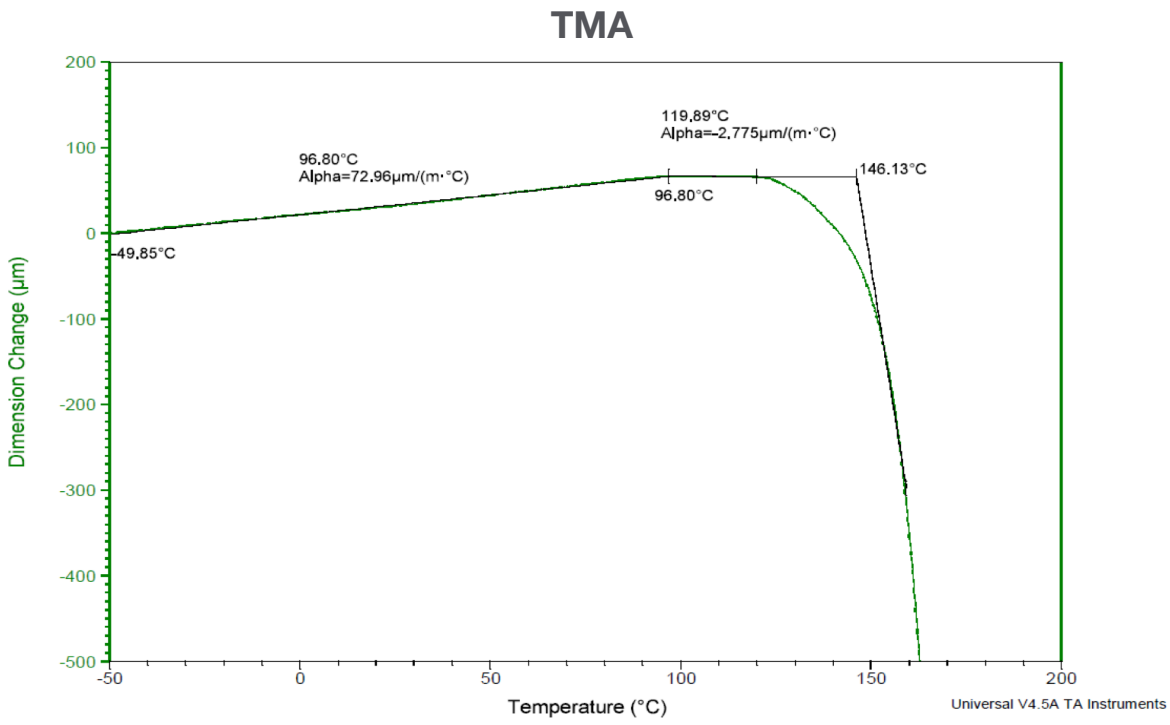
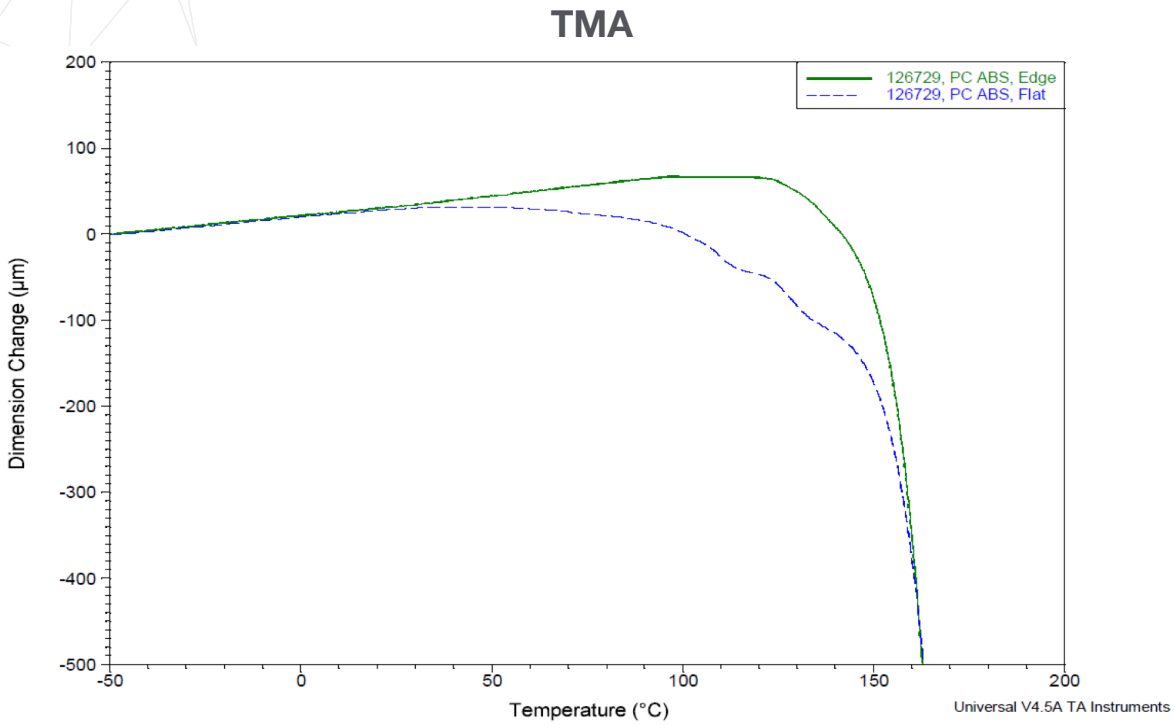


Figure 4. Overlay of the dimension change data for the Flat (XY) and On Edge (XZ) PC-ABS samples.



Stratasys Headquarters

7665 Commerce Way,
Eden Prairie, MN 55344
+1 800 801 6491 (US Toll Free)
+1 952 937-3000 (Intl)
+1 952 937-0070 (Fax)

1 Holtzman St., Science Park,
PO Box 2496
Rehovot 76124, Israel
+972 74 745 4000
+972 74 745 5000 (Fax)

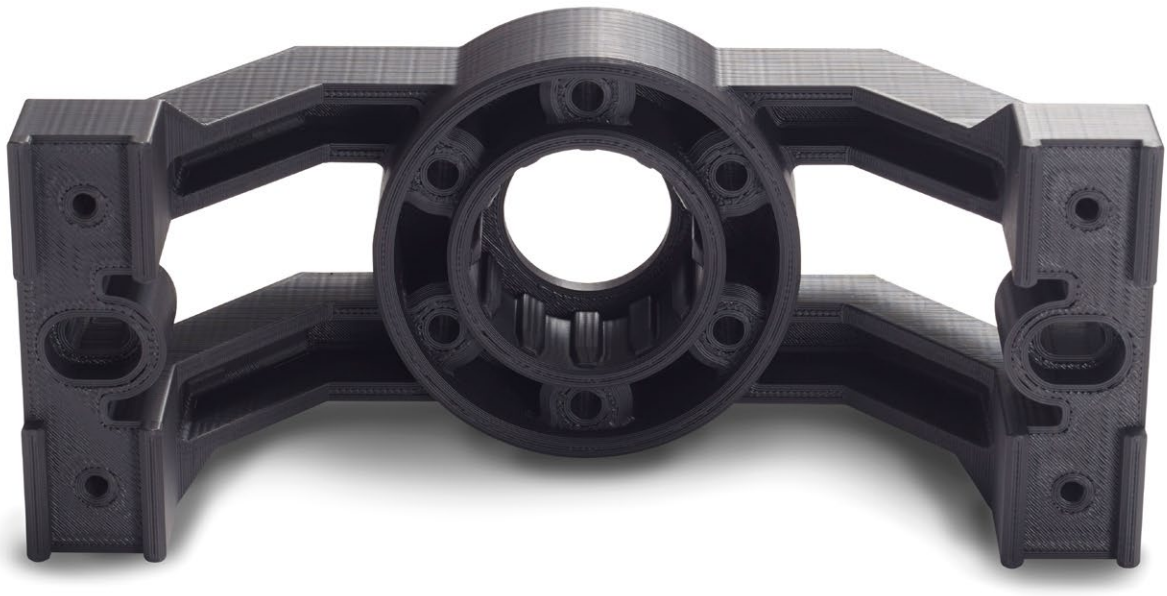
stratasys.com
ISO 9001:2015 Certified

Diran 410MF07

FDM Thermoplastic Filament

Perfect for manufacturing tooling applications.

The information presented are typical values intended for reference and comparison purposes only.
They should not be used for design specifications or quality control purposes.



Overview

Diran™ 410MF07 is a nylon-based thermoplastic FDM® material, mineral-filled 7% by weight. It demonstrates very good toughness and impact strength combined with resistance to hydrocarbon-based chemicals. Its smooth, lubricious surface quality offers low sliding resistance.

Typical applications include jigs, fixtures and other forms of general manufacturing tooling, and is particularly effective for applications needing a non-marring interface between the tool and the workpiece.

Contents:

Overview 2
Ordering Information 3
Physical Properties 4
Mechanical Properties 5
Appendix 7

Ordering Information

3D Printer Compatibility: F370™

Support Material: SUP4000B™

Build Tray: F370, High Temperature

Table 1. Diran 410MF07 Thermoplastic Filament Ordering Information

Part Number	Description
Filament Canisters	
333-90410	Diran 410MF07, 90 cu in, F123
333-60400	SUP4000B™, 60 cu in, F123
Printer Consumables	
123-00300	F370 Extrusion Head
123-00314-S	F370 Build Tray, High Temperature

Physical Properties

Values are measured as printed. XY and XZ/ZX orientations were tested.

For full details refer to the Stratasys Materials Test Procedure on www.stratasys.com.

DSC and TMA curves can be found in the Appendix.

Table 2. Diran 410MF07 Thermoplastic Filament Physical Properties

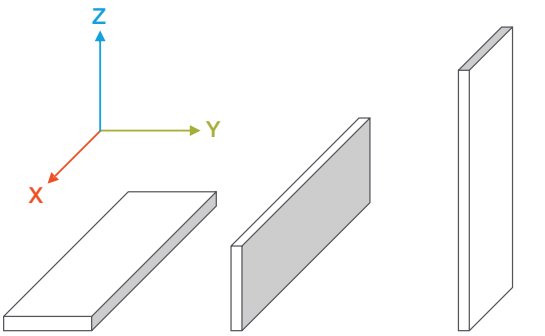
Property	Test Method	Typical Values XY	Typical Values XZ/ZX
HDT @ 66psi	ASTM D648 Method B	90 °C (194 °F)	90 °C (194 °F)
HDT @ 264psi	ASTM D648 Method B	70 °C (158 °F)	70 °C (158 °F)
Tg	ASTM D7426 Inflection Point	117 °C (243 °F)	117 °C (243 °F)
Mean CTE	ASTM E831 (40 °C to 140 °C)	55 µm/[m·°C] (31 µin/[in·°F])	113 µm/[m·°C] (63 µin/[in·°F])
Volume Resistivity	ASTM D257	> $1.5*10^{15}$ Ω·cm	> $1.5*10^{15}$ Ω·cm
Dielectric Constant	ASTM D150 1 kHz test condition	3.58	3.73
Dielectric Constant	ASTM D150 2 MHz test condition	2.85	2.95
Dissipation Factor	ASTM D150 1 kHz test condition	0.013	0.014
Dissipation Factor	ASTM D150 2 MHz test condition	0.000	0.012
Specific Gravity	ASTM D792 @ 23 °C	1.16	1.16

Mechanical Properties

Samples were printed with 0.010 in. (0.254 mm) layer height.
For the full test procedure please see the Stratasys Materials Test Procedure on www.stratasys.com.

Print Orientation

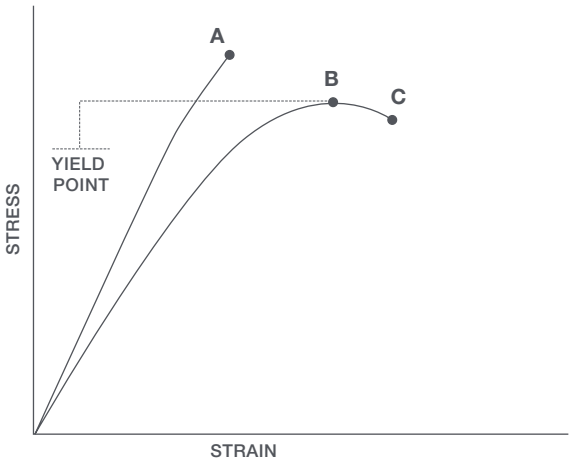
Parts created using FDM are anisotropic as a result of the printing process. Below is a reference of the different orientations used to characterize the material.



Flat (XY) On Edge (XZ) Upright (ZX)

Tensile Curves

Due to the anisotropic nature of FDM, tensile curves look different depending on orientation. Below is a guide of the two types of curves seen when printing tensile samples and what reported values mean.



A = Tensile at break, elongation at break (no yield point)
B = Tensile at yield, elongation at yield
C = Tensile at break, elongation at break

Table 3. Diran 410MF07 Thermoplastic Filament Mechanical Properties

		XZ Orientation[1]	ZX Orientation[1]
Tensile Properties: ASTM D638			
Yield Strength	MPa	45 (2)	No yield
	psi	6,490 (220)	No yield
Elongation @ Yield	%	4.26 (0.04)	No yield
Strength @ Break	MPa	40 (3)	30 (2)
	psi	5,860 (440)	4,460 (295)
Elongation @ Break	%	12 (3)	3.1 (1.0)
Modulus (Elastic)	GPa	1.69 (0.02)	1.46 (0.02)
	ksi	245 (3)	210 (3)
Flexural Properties: ASTM D790, Procedure A			
Strength @ Break	MPa	No break	45 (2)
	psi	No break	6,770 (325)
Strength @ 5% Strain	MPa	60 (2)	-
	psi	8,800 (230)	-
Strain @ Break	%	No break	3.1 (0.6)
Modulus	GPa	1.85 (0.04)	1.47 (0.07)
	ksi	270 (6)	210 (10)
Compression Properties: ASTM D695			
Yield Strength	MPa	75 (5)	160 (30)
	psi	10,980 (630)	23,560 (4330)
Modulus	GPa	1.54 (0.03)	1.45 (0.02)
	ksi	220 (4)	210 (3)
Impact Properties: ASTM D256, ASTM D4812			
Izod, Notched	J/m	380 (135)	27 (5)
	ft*lb/in	7 (3)	0.5 (0.1)
Izod, Unnotched	J/m	1,415 (200)	140 (25)
	ft*lb/in	25 (4)	2.6 (0.5)

(1) Values in parentheses are standard deviations

Appendix

Figure 1. 2nd heating scan, DSC, for Diran 410MF07

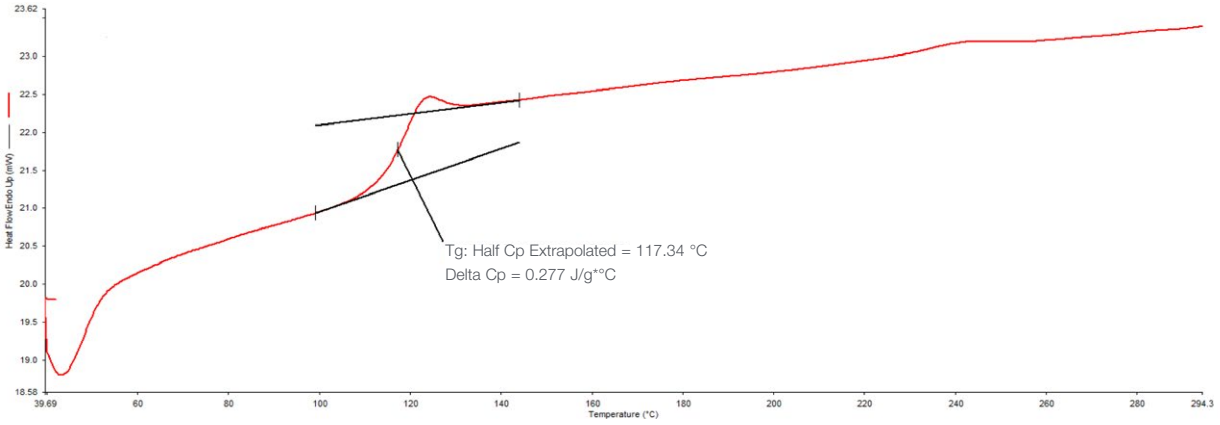


Figure 2. TMA CTE curve inplane with the layer

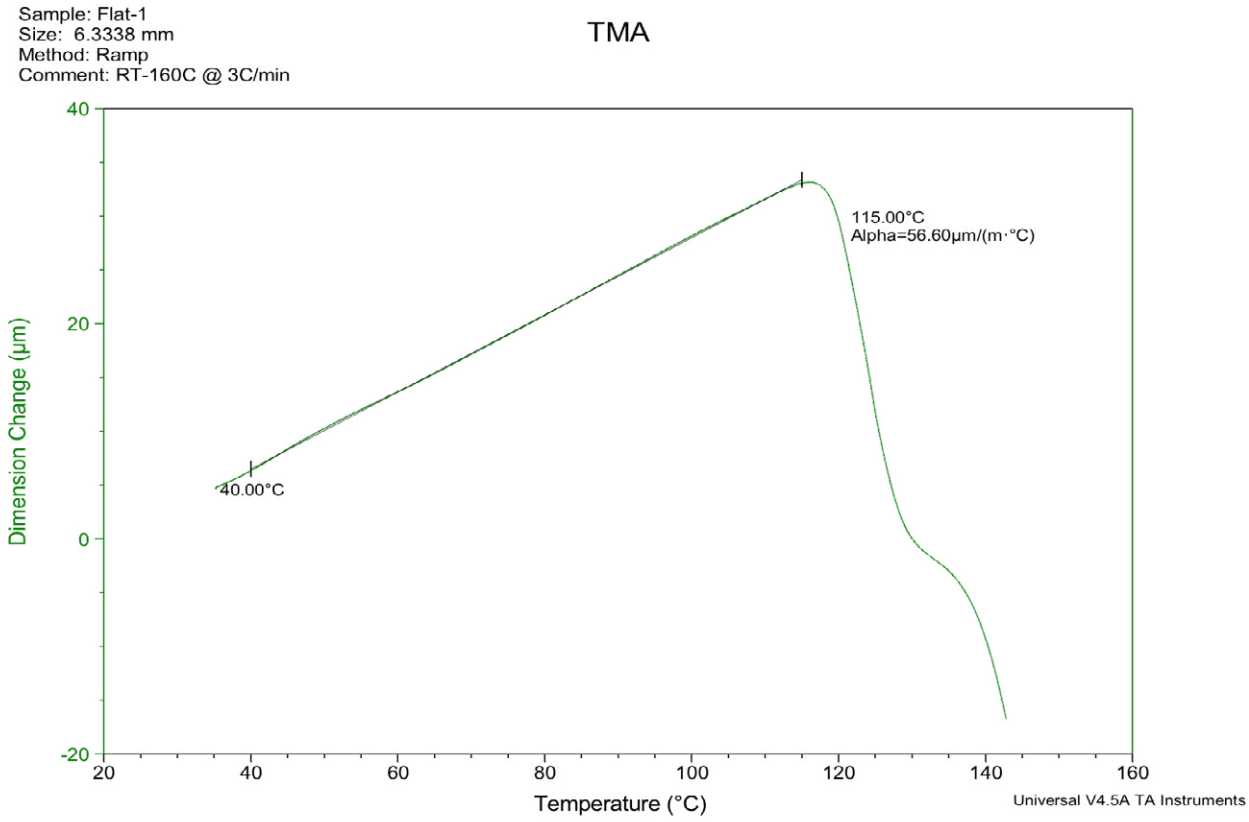
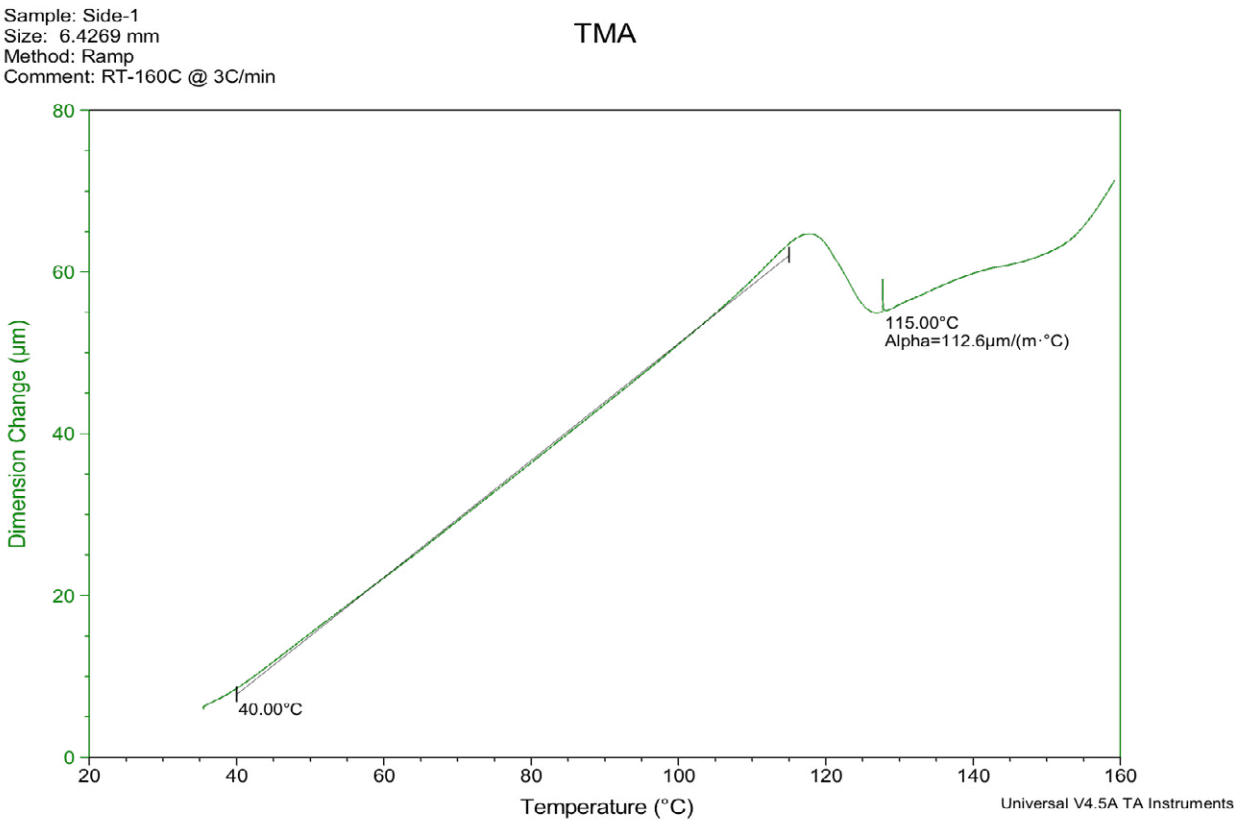


Figure 3. TMA CTE curve normal to the layer



Stratasys Headquarters

7665 Commerce Way,
Eden Prairie, MN 55344
+1 800 801 6491 (US Toll Free)
+1 952 937-3000 (Intl)
+1 952 937-0070 (Fax)

1 Holtzman St., Science Park,
PO Box 2496
Rehovot 76124, Israel
+972 74 745 4000
+972 74 745 5000 (Fax)

stratasys.com
ISO 9001:2015 Certified

ABS-CF10

Carbon Fiber Filled ABS
FDM Thermoplastic Filament

The information presented are typical values intended for reference and comparison purposes only.
They should not be used for design specifications or quality control purposes.

Overview

Stratasys ABS-CF10 combines standard ABS (acrylonitrile butadiene styrene) material with 10% chopped carbon fiber by weight. The result is a low moisture-sensitive FDM® thermoplastic 50% stiffer and 15% stronger than standard ABS 3D printing material.

Typical applications include manufacturing tools, jigs, fixtures and end effectors that benefit from the combination of increased stiffness and reduced weight.

Contents:

Product and Ordering Information 3
Physical Properties 4
Mechanical Properties 5
Appendix 7

Product Information

Table 1. Printer Compatibility

Printer	Model Tip (Slice)	Support Material	Support Tip
F170™	F123 Head (7, 10, 13 slice)	QSR™	F123 Head (7, 10, 13 slice)
F270™	F123 Head (7, 10, 13 slice)	QSR	F123 Head (7, 10, 13 slice)
F370™	F123 Head (7, 10, 13 slice)	QSR	F123 Head (7, 10, 13 slice)

Support Material

- QSR soluble support

Build Tray

- F123 standard build trays

Table 2. ABS-CF10 Ordering Information

Part Number	Description
Filament Canisters	
333-90310	ABS-CF10, 90 cu. in.
333-63500	QSR Soluble Support, 60 cu. in. - F123
Printer Consumables	
123-00601-S	Dedicated ABS-CF10 Head (Green Cover) Recommended
123-00401-S	F370 Extrusion Head
123-00302-S	F170 Build Tray
123-00303	F270 Build Tray, Standard
123-00304	F370 Build Tray, Standard

Physical Properties

Values are measured as printed. XY, XZ, and ZX orientations were tested. For full details refer to the Stratasys Materials Test Report (immediate download upon clicking the link). DSC and TMA curves can be found in the Appendix.

Table 3. ABS-CF10 Physical Properties

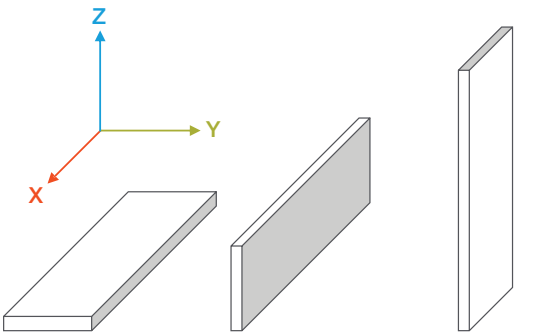
Property	Test Method	Typical Values	
		XY	XZ/ZX
HDT @ 66 psi	ASTM D648 Method B	100 °C (212 °F)	
HDT @ 264 psi	ASTM D648 Method B	99 °C (210 °F)	
Tg	ASTM D7426 Inflection Point	104 °C (219 °F)	
Mean CTE	ASTM E831 (-50 °C to 100 °C)	19 µm/[m*°C] (11 µin/[in*°F])	76 µm/[m*°C] (42 µin/[in*°F])
Volume Resistance	ASTM D257	4.6×10^{12}	
Specific Gravity	ASTM D257 @23 °C	1.0972	

Mechanical Properties

ABS-CF10 samples were printed with a 0.010 in. (0.254 mm) layer height on the F370. For the full test procedure please see the Stratasys Materials Test Procedure (immediate download upon clicking the link).

Print Orientation

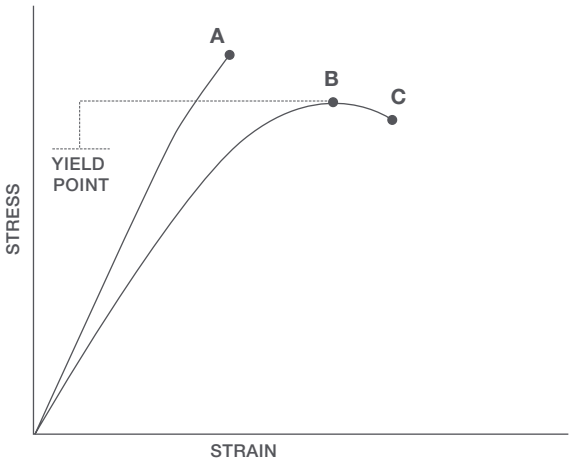
Parts created using FDM are anisotropic as a result of the printing process. Below is a reference of the different orientations used to characterize the material.



Flat (XY) On Edge (XZ) Upright (ZX)

Tensile Curves

Due to the anisotropic nature of FDM, tensile curves look different depending on orientation. Below is a guide of the two types of curves seen when printing tensile samples and what reported values mean.



A = Tensile at break, elongation at break (no yield point)
B = Tensile at yield, elongation at yield
C = Tensile at break, elongation at break

Table 4. ABS-CF10 Mechanical Properties

0.010 in layer height		XZ Orientation	ZX Orientation
Tensile Properties: ASTM D638			
Yield Strength	MPa	No yield	21.2 (0.48)
	psi	No yield	3080 (69)
Elongation @ Yield	%	No yield	1.49 (0.08)
Strength @ Break	MPa	37.7 (1.38)	21.3 (0.48)
	psi	5465 (200)	3100 (70)
Elongation @ Break	%	2.70 (0.20)	1.49 (0.09)
Modulus (Elastic)	GPa	3.342 (0.12)	1.958 (0.028)
	ksi	484.6 (18)	283.9 (4.1)
Flexural Properties: ASTM D790, Procedure A			
Strength @ Break	MPa	69.0 (2.4)	29.2 (0.86)
	psi	10000 (350)	4240 (120)
Strain @ Break	%	2.45 (0.11)	1.89 (0.08)
Modulus	GPa	3.76 (0.099)	1.75 (0.051)
	ksi	545 (14)	254 (7.5)
Compression Properties: ASTM D695			
Yield Strength	MPa	No yield	No yield
	psi	No yield	No yield
Peak Strength	MPa	73.2 (4.5)	94.8 (2.56)
	psi	10620 (650)	13740 (370)
Modulus	GPa	2.129 (0.093)	1.917 (0.063)
	ksi	309 (13.6)	278 (9.2)
Impact Properties: ASTM D256, ASTM D4812			
Notched	J/m	51.4 (1.9)	20.3 (2.8)
	ft*lb/in	0.962 (0.04)	0.381 (0.05)
Unnotched	J/m	212 (25)	47.0 (6.4)
	ft*lb/in	3.97 (0.47)	0.881 (0.12)

(1) Values in parentheses are standard deviations.

Appendix

Figure 1. DSC data for the ABS-CF10 sample.

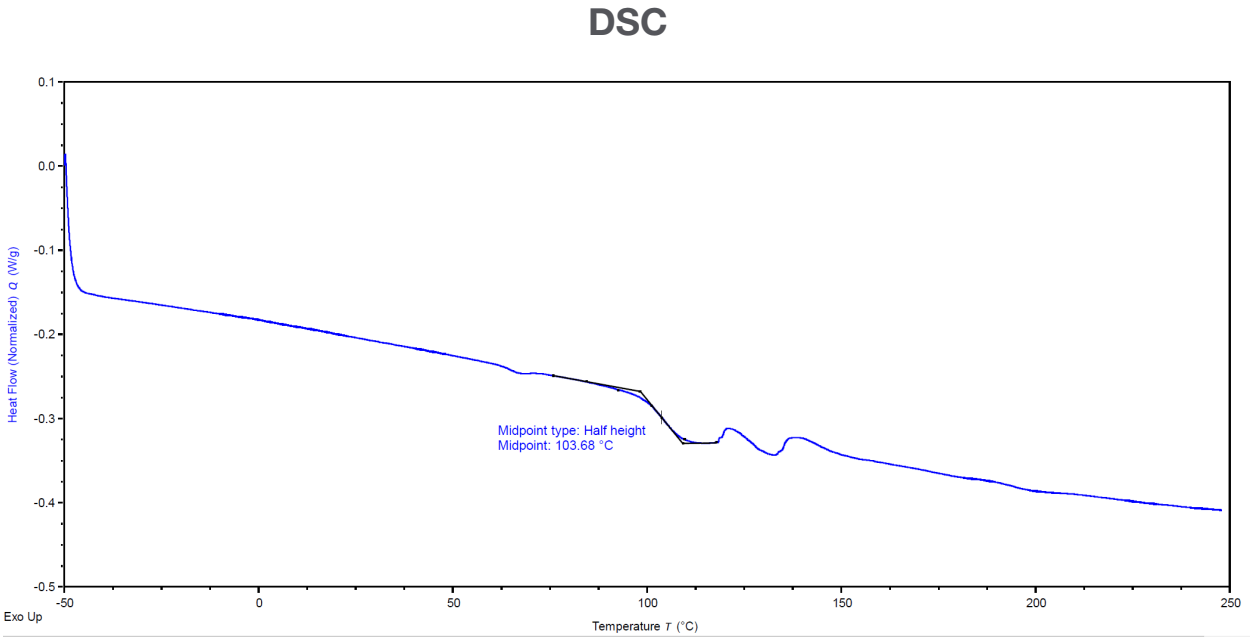


Figure 2. Dimension change data as a function of temperature for ABS-CF10 Flat (XY) sample.

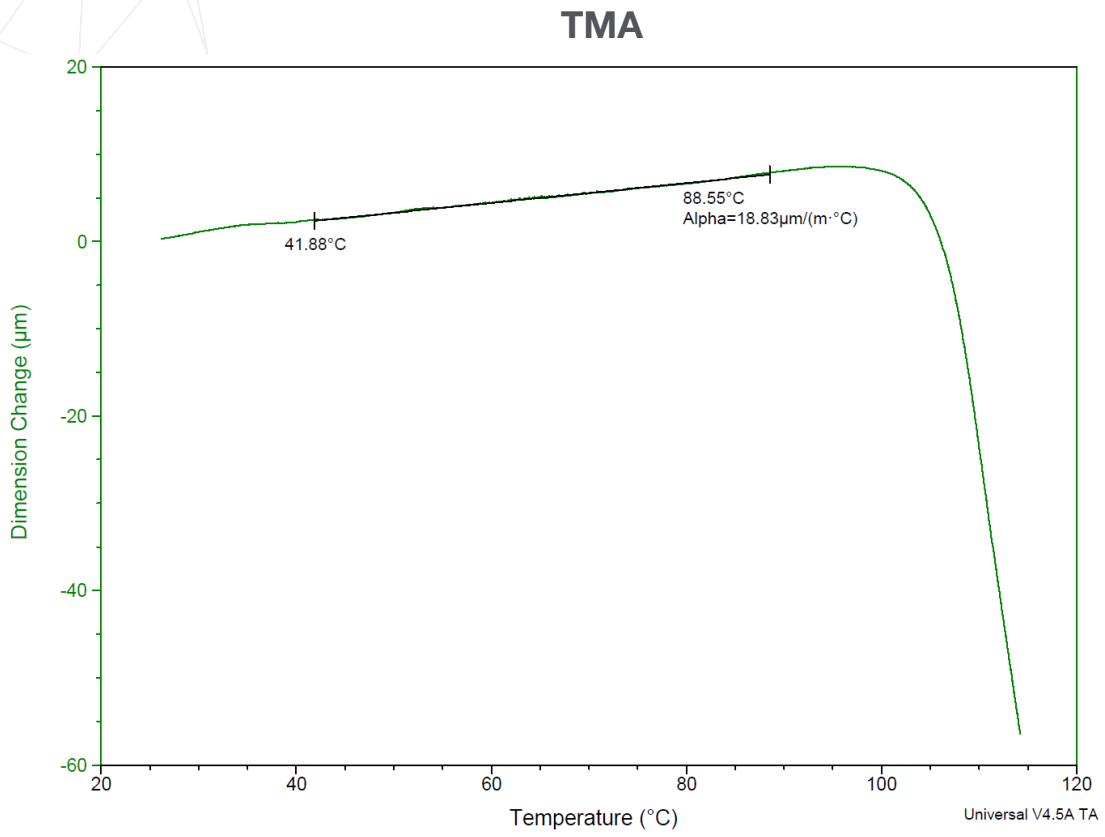
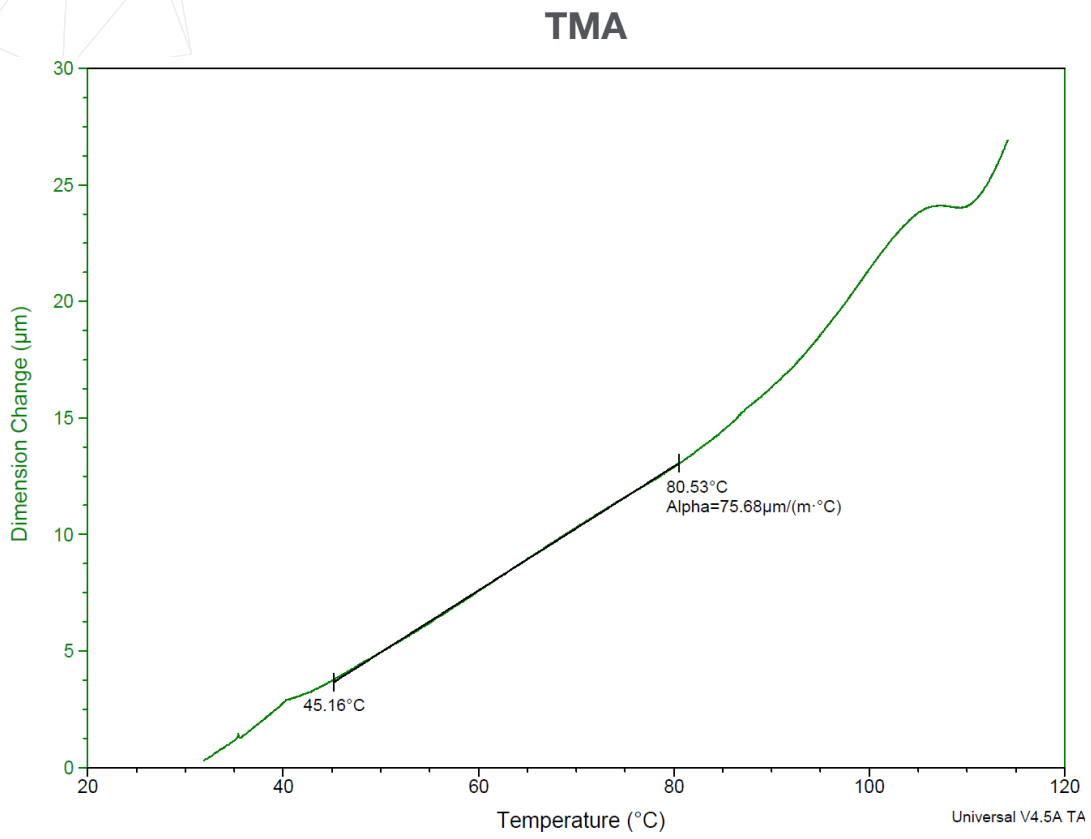


Figure 3. Dimension change data as a function of temperature for ABS-CF10 On Edge (XZ) sample.



Stratasys Headquarters

7665 Commerce Way,
Eden Prairie, MN 55344
+1 800 801 6491 (US Toll Free)
+1 952 937-3000 (Intl)
+1 952 937-0070 (Fax)

1 Holtzman St., Science Park,
PO Box 2496
Rehovot 76124, Israel
+972 74 745 4000
+972 74 745 5000 (Fax)

stratasys.com
ISO 9001:2015 Certified

FDM TPU 92A

FDM® TPU 92A is a thermoplastic polyurethane with a Shore A value of 92. The material exhibits high elongation, superior toughness, durability and abrasion resistance.

FDM TPU 92A brings the benefits of elastomers to FDM 3D printing and offers the capability to quickly produce large and complex elastomer parts. Typical applications include flexible hoses, tubes, air ducts, seals, protective covers and vibration dampeners.

FDM TPU 92A is available on the F123™ Series 3D Printers and is compatible with QSR™ soluble support material.

Mechanical Properties	Test Method	Value	
		XY Orientation	XZ Orientation
Shore Hardness (molded)	ASTM D2240	92 Shore A	92 Shore A
Tensile Strength, Yield (Type 1, 0.125”, 0.2”/min)	ASTM D412	15.6 MPa (2,265 psi)	16.1 MPa (2,332 psi)
Tensile Strength, Ultimate (Type 1, 0.125”, 0.2”/min)	ASTM D412	16.8 MPa (2,432 psi)	17.4 MPa (2,519 psi)
Tensile Modulus (Type 1, 0.125”, 0.2”/min)	ASTM D412	15.3 MPa (2,212 psi)	20.7 MPa (3,000 psi)
Elongation at Break (Type 1, 0.125”, 0.2”/min)	ASTM D412	552%	482%
Elongation at Yield (Type 1, 0.125”, 0.2”/min)	ASTM D412	466%	385%
Tensile Stress at 100% Elongation (PSI)	ASTM D412	6.9 MPa (999 psi)	7.6 MPa (1,096 psi)
Tensile Stress at 300% Elongation (PSI)	ASTM D412	11.0 MPa (1,598 psi)	11.9 MPa (1,722 psi)
Flexural Strength (Method 1, 0.05”/min)	ASTM D790	1.8 MPa (255 psi)	2.4 MPa (351 psi)
Flexural Modulus (Method 1, 0.05”/min)	ASTM D790	25.6 MPa (3,719 psi)	36.9 MPa (5,349 psi)
Flexural Strain at Break (Method 1, 0.05”/min)	ASTM D790	No break	No break
Tear Strength - Stamped	ASTM D624-C	84.6 N/mm (483 lbF/in)	NA
Compressive Strength, Yield (Method 1, 0.05”/min)	ASTM D695	2.6 MPa (384 psi)	2.6 MPa (384 psi)
Compressive Strength, Ultimate (Method 1, 0.05”/min)	ASTM D695	2.6 MPa (384 psi)	2.6 MPa (384 psi)
Compressive Modulus (Method 1, 0.05”/min)	ASTM D695	16.9 MPa (2,457 psi)	16.9 MPa (2,457 psi)
Compression Set at 22 Hours @ 23 ºC	ASTM D395	21%	NA
Compression Set at 22 Hours @ 70 ºC	ASTM D395	44%	NA

FDM TPU 92A

Thermal Properties	Test Method	Value
Heat Deflection (HDT) @ 66 psi	ASTM D648	38 °C (100.4 °F)
Heat Deflection (HDT) @ 15 psi	NA	56 °C (132.8 °F)
Vicat Softening Temperature (Rate B/50)	ASTM D1525	95 °C (203 °F)
Glass Transition Temperature (Tg)	DMA (SSYS)	-42 °C (-43.6 °F)
Coefficient of Thermal Expansion (x-direction)	ASTM E831	139 µm/(m·°C) (7.72E-05 in/(in·°F))
Coefficient of Thermal Expansion (y-direction)	ASTM E831	159 µm/(m·°C) (8.83E-05 in/(in·°F))
Coefficient of Thermal Expansion (z-direction)	ASTM E831	176 µm/(m·°C) (9.78E-05 in/(in·°F))

Electrical Properties	Test Method	Value	
		XY Orientation	XZ Orientation
Volume Resistivity	ASTM D257	6.09E+10 ohm-cm	7.17E+13 ohm-cm

Other	Test Method	Value
Specific Gravity	ASTM D792	1.13502

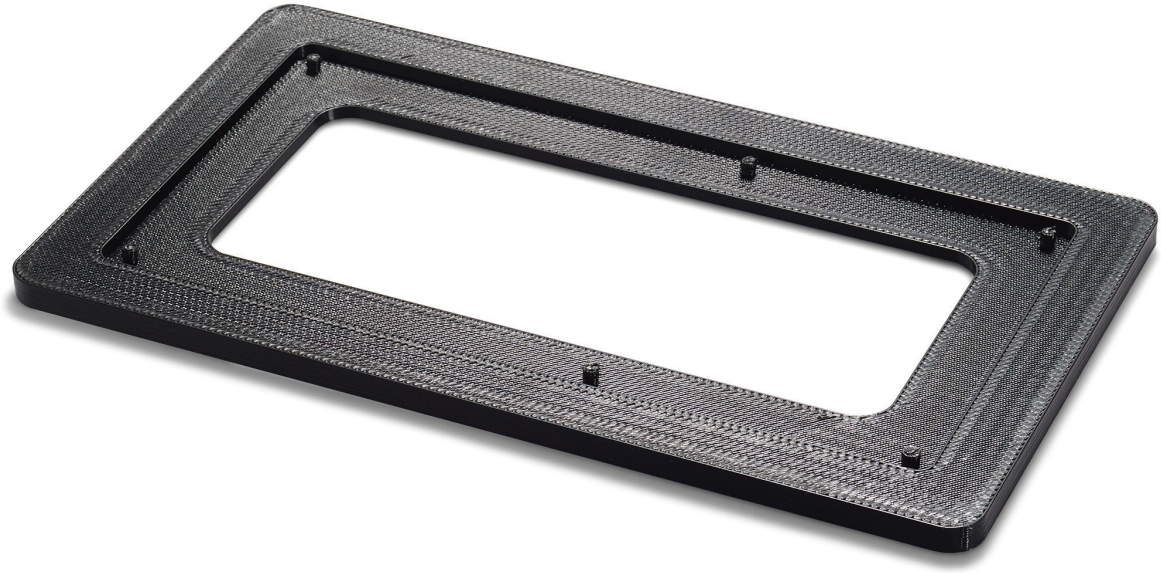
Stratasys Headquarters

7665 Commerce Way,
Eden Prairie, MN 55344
+1 800 801 6491 (US Toll Free)
+1 952 937-3000 (Intl)
+1 952 937-0070 (Fax)

stratasys.com
ISO 9001:2008 Certified

1 Holtzman St., Science Park,
PO Box 2496
Rehovot 76124, Israel
+972 74 745 4000
+972 74 745 5000 (Fax)

ABS-ESD7



Electrostatic-Dissipative FDM Thermoplastic Filament

The information presented are typical values intended for reference and comparison purposes only.
They should not be used for design specifications or quality control purposes.

Overview

ABS-ESD7™ (acrylonitrile butadiene styrene-electrostatic dissipative) is an ABS thermoplastic with static dissipative properties suited for static discharge-sensitive applications. ABS-ESD7 prevents static electricity buildup so it will not produce a discharge or attract other materials like powders, dust and fine particles.

The material is ideal for jigs and fixtures used to fabricate and assemble electronic components and associated production line and conveyor parts. It is also useful for producing functional prototypes, enclosures and packaging.

Contents:

Overview 2

Ordering Information 3

Physical Properties 4

Mechanical Properties 5

ESD Properties 8

Appendix 9

Ordering Information

Table 1. Printer and Support Material Compatibility

Printer	Model Tip (Slice)	Support Material	Support Tip
F370™	F123 Head (7 slice) F123 Head (10 slice)	QSR Support™ (soluble)	F123 Head (all slices)
Fortus 400mc™	T12 (7 slice) T16 (10 slice)	SR30™/35™ (soluble)	T12SR30 (all slices)
Fortus 380mc™/450mc™	T12 (7 slice) T16 (10 slice)	SR30/35 (soluble)	T12SR30 (all slices)
Fortus 900mc™/F900™	T12 (7 slice) T16 (10 slice)	SR30/35 (soluble)	T12SR30 (all slices)

Build Sheets

Low temperature

0.02 x 26 x 38 in. (0.51 x 660 x 965 mm)

0.02 x 16 x 18.5 in. (0.51 x 406 x 470 mm)

0.03 x 16 x 18.5 in (0.76 x 406 x 470 mm)

0.02 x 14 x 16.5 in. (0.51 x 355 x 417 mm)

F370 Standard build tray

Table 2. ABS-ESD7 Ordering Information

Part Number	Description
Filament Canisters (1)(2)	
355-02130	ABS-ESD7, 92.3 cu. in. – Plus
311-20800	ABS-ESD7, 92.3 cu. in. – Classic
333-90230	ABS-ESD7, 90 cu. in. – F123
355-03110	SR-30™ Soluble Support, 92.3 cu. in. – Plus
360-53110	XTEND™ SR-30 Soluble Support, 500 cu. in. – Plus
311-30200	SR-30 Soluble Support, 92.3 cu. in. – Classic
355-03135	SR-35™ Soluble Support, 92.3 cu. in. – Plus
311-30235	SR-35 Soluble Support, 92.3 cu. in. – Classic
333-63500	QSR Support™, 60 cu. in. – F123™
Printer Consumables	
123-00401-S	F370 extrusion head, 0.007 in. (0.178 mm) and 0.010 in. (0.254 mm) layer height
511-10301(3)	T12 tip, 0.007 in. (0.178 mm) layer height
511-10401(3)	T16 tip, 0.010 in. (0.254 mm) layer height
511-10900(3)	T12SR30 support tip, all layer heights
123-00304	F370 Build Tray, Standard
325-00300(4)	Low Temperature build sheet, 0.02x26x38 in. (0.51x660x965 mm)
325-00100(5)	Low Temperature build sheet, 0.02x16x18.5 in. (0.51x406x470 mm)
310-00100(6)	Low Temperature build sheet, 0.03x16x18.5 in. (0.76x406x470 mm)
355-00100(7)	Low Temperature build sheet, 0.02x14x16.5 in. (0.51x355x420 mm)
123-00401-S(8)	F123 Extrusion Head, 0.005 - 0.013 in layer height
123-00304	F370 Build Tray, Standard

(1) Classic canisters are compatible with all Fortus 400mc and Fortus 900mc printers prior to s/n L502
(2) Plus canisters are compatible with all Fortus 450mc, all Stratasys F900, and Fortus 900mc printers s/n L502 and up
(3) Compatible with Fortus 380mc, Fortus 450mc, Stratasys F900 and Fortus 900mc
(4) Compatible with Stratasys F900 and Fortus 900mc
(5) Compatible with Fortus 450mc, Stratasys F900 and Fortus 900mc
(6) Compatible with Fortus 400mc
(7) Compatible with Fortus 380mc
(8) Compatible with F370"

Physical Properties

Values are measured as printed. XY and XZ/ZX orientations were tested.

For full details, refer to the Stratasys Materials Test Procedure on stratasys.com.

DSC and TMA curves can be found in the Appendix.

Table 3. ABS-ESD7 Physical Properties

Property	Test Method	Typical Values	
		XY	XZ/ZX
HDT @ 66 psi	ASTM D648 Method B	104.6 C (220.2 F)	
HDT @ 264 psi	ASTM D648 Method B	101.4 C (214.6 F)	
Tg	ASTM D7426 Inflection Point	105.46 C (221.83 F)	
Mean CTE	ASTM E831 (-50 °C to 100 °C)	56.15 µm/[m*°C] (31.19 µin/[in*°F])	63.26 µm/[m*°C] (35.14 µin/[in*°F])
Volume Resistance	ASTM D257	10^4-10^9* Ω	
Specific Gravity	ASTM D257 @23 °C	1.07	

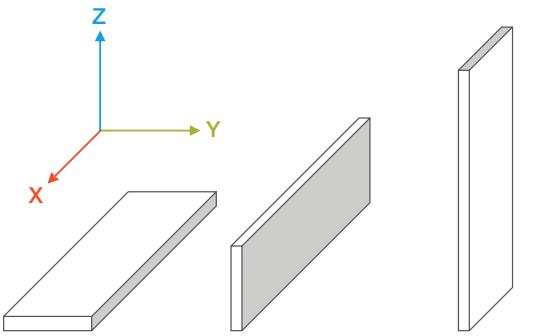
* See ESD section for details

Mechanical Properties

Samples were printed with 0.010 in. (0.254 mm) layer height.
For the full test procedure, please see the Stratasys Materials Test Procedure on stratasys.com.

Print Orientation

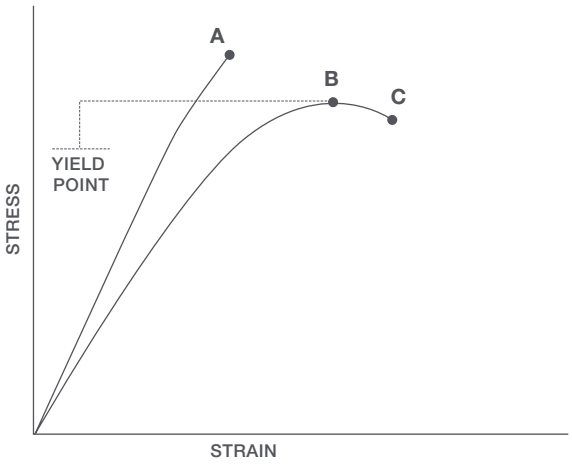
Parts created using FDM are anisotropic as a result of the printing process. Below is a reference of the different orientations used to characterize the material.



Flat (XY) On Edge (XZ) Upright (ZX)

Tensile Curves

Due to the anisotropic nature of FDM, tensile curves look different depending on orientation. Below is a guide of the two types of curves seen when printing tensile samples and what reported values mean.



A = Tensile at break, elongation at break (no yield point)
B = Tensile at yield, elongation at yield
C = Tensile at break, elongation at break

Table 4. ABS-ESD7 Mechanical Properties (F900 – T16 Tip)

		XZ Orientation	ZX Orientation
Tensile Properties: ASTM D638			
Yield Strength	MPa	35.4 (1.3)	No yield
	psi	5130 (190)	No yield
Elongation @ Yield	%	2.1 (0.050)	No yield
Strength @ Break	MPa	33.9 (1.0)	27.0 (2.3)
	psi	4920 (150)	3920 (330)
Elongation @ Break	%	3.4 (0.52)	1.59 (0.29)
Modulus (Elastic)	GPa	2.69 (0.10)	2.28 (0.21)
	ksi	391 (15)	330 (31)
Flexural Properties: ASTM D790, Procedure A			
Strength @ Break	MPa	No break	44.3 (2.6)
	psi	No break	6440 (370)
Strength @ 5% Strain	MPa	67.5 (1.2)	-
	psi	9800 (170)	-
Strain @ Break	%	No break	2.67 (0.14)
Modulus	GPa	2.41 (0.073)	2.04 (0.084)
	ksi	350 (11)	296 (12)
Compression Properties: ASTM D695			
Yield Strength	MPa	95.3 (2.5)	202 (11)
	psi	13800 (370)	29300 (1500)
Modulus	GPa	2.39 (0.090)	2.40 (0.33)
	ksi	346 (13)	348 (48)
Impact Properties: ASTM D256, ASTM D4812			
Notched	J/m	36.2 (3.0)	20.5 (1.6)
	ft*lb/in	0.678 (0.057)	0.384 (0.029)
Unnotched	J/m	198 (36)	85.4 (18)
	ft*lb/in	3.72 (0.67)	1.60 (0.35)

Table 5. ABS-ESD7 Mechanical Properties (F370)

		XZ Orientation	ZX Orientation
Tensile Properties: ASTM D638			
Yield Strength	MPa	33.3 (0.70)	No yield
	psi	4830 (100)	No yield
Elongation @ Yield	%	2.1 (0.035)	No yield
Strength @ Break	MPa	31.8 (0.77)	23.2 (0.34)
	psi	4610 (110)	3370 (49)
Elongation @ Break	%	2.4 (0.21)	1.8 (0.071)
Modulus (Elastic)	GPa	2.12 (0.029)	1.73 (0.020)
	ksi	308 (4.3)	252 (2.9)
Flexural Properties: ASTM D790, Procedure A			
Strength @ Break	MPa	60.4 (2.5)	29.8 (3.4)
	psi	8770 (360)	4320 (490)
Strain @ Break	%	3.81 (0.26)	2.00 (0.29)
Modulus	GPa	2.25 (0.026)	1.65 (0.036)
	ksi	326 (3.8)	240 (5.2)
Compression Properties: ASTM D695			
Yield Strength	MPa	52.8 (2.2)	59.6 (1.4)
	psi	7660 (320)	865 (200)
Peak Strength	MPa	-	150 (17)
	psi	-	21800 (2500)
Modulus	GPa	1.74 (0.062)	1.73 (0.025)
	ksi	252 (9.0)	251 (3.7)
Impact Properties: ASTM D256, ASTM D4812			
Notched	J/m	41.4 (3.0)	18 (2.7)
	ft*lb/in	0.776 (0.056)	0.337 (0.051)
Unnotched	J/m	343 (41)	69.1 (6.6)
	ft*lb/in	6.42 (0.77)	1.30 (0.12)

ESD Properties

ABS-ESD7 was tested per ANSI ESD S20.20, S11.11, STM11.12 to determine the effect that build parameters and part geometries have on ESD properties. Different geometries printed in different orientations fall into the ESD safe range (10^4 to 10^9 ohms), with some variability in thin-walled cylinders. For full details, see the ABS-ESD7 ESD White Paper.

Figure 1. 4 x 4 x 0.1 in. plaque resistance in various build orientations.

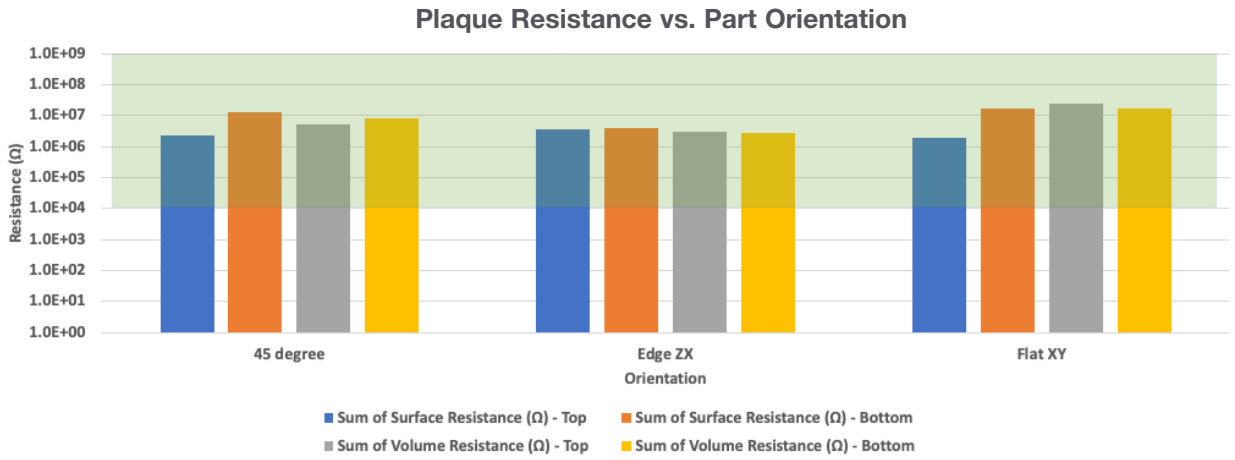
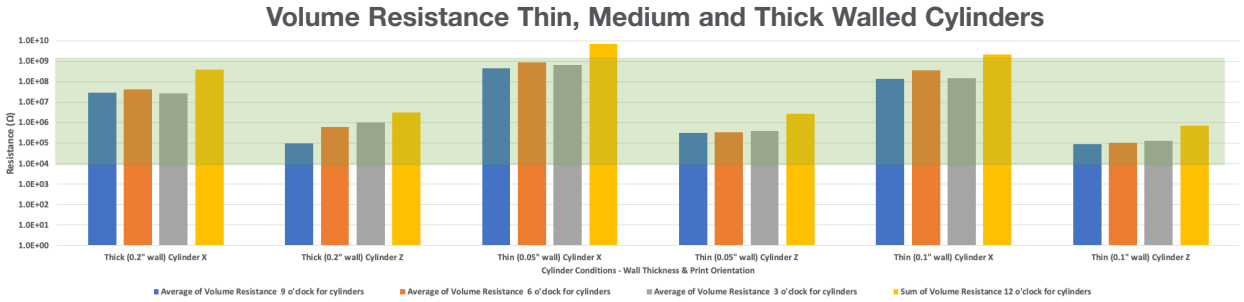


Figure 2. Volume resistance of hollow cylinders with respect to wall thickness, build orientation, and location on the cylinder.



Appendix

Figure 3. Dimension change data as a function of temperature for the ABS-ESD7 Flat (XY) sample.

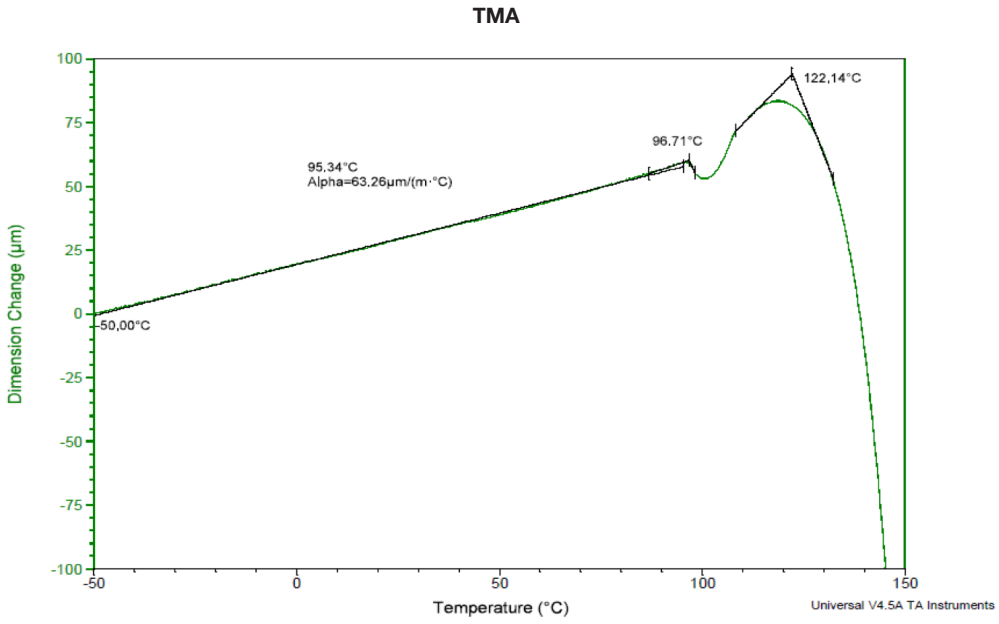


Figure 4. Dimension change data as a function of temperature for the ABS-ESD7 On Edge (XZ) sample.

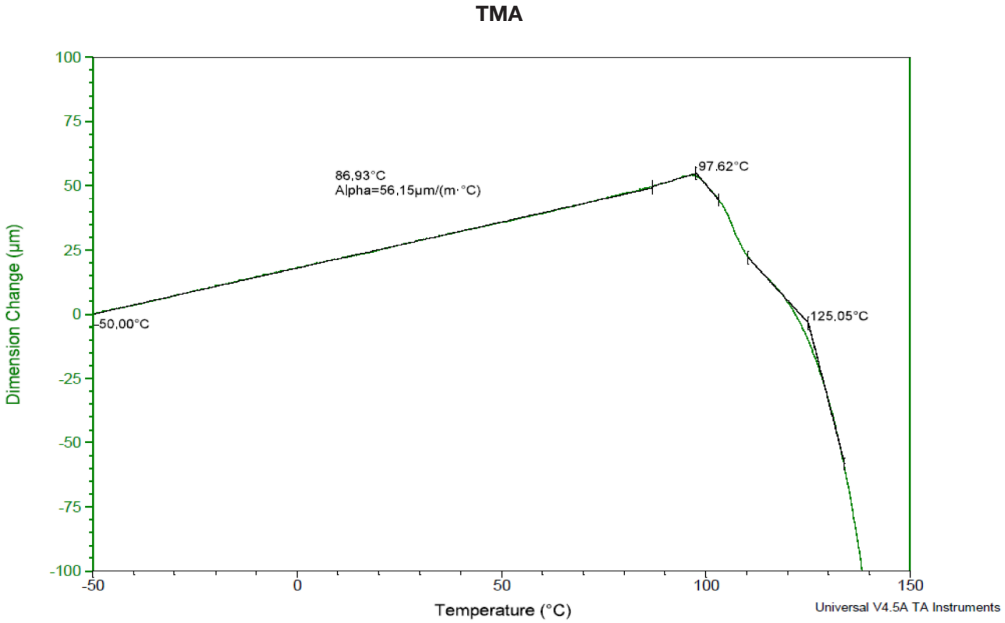


Figure 5. Overlay of the dimension change data for the Flat (XY) and On Edge (XZ) ABS-ESD7 samples.

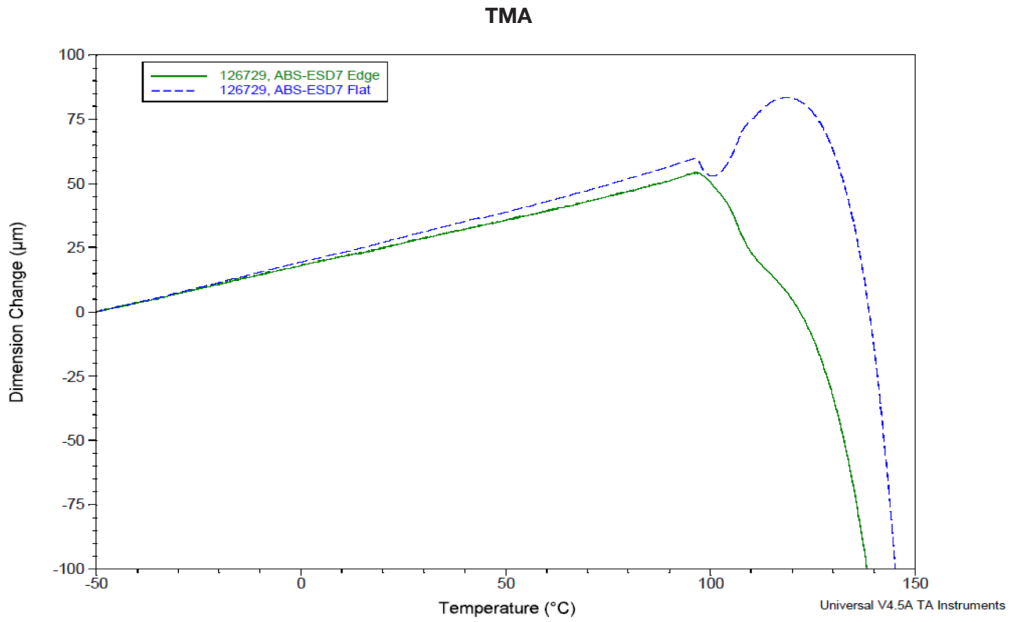
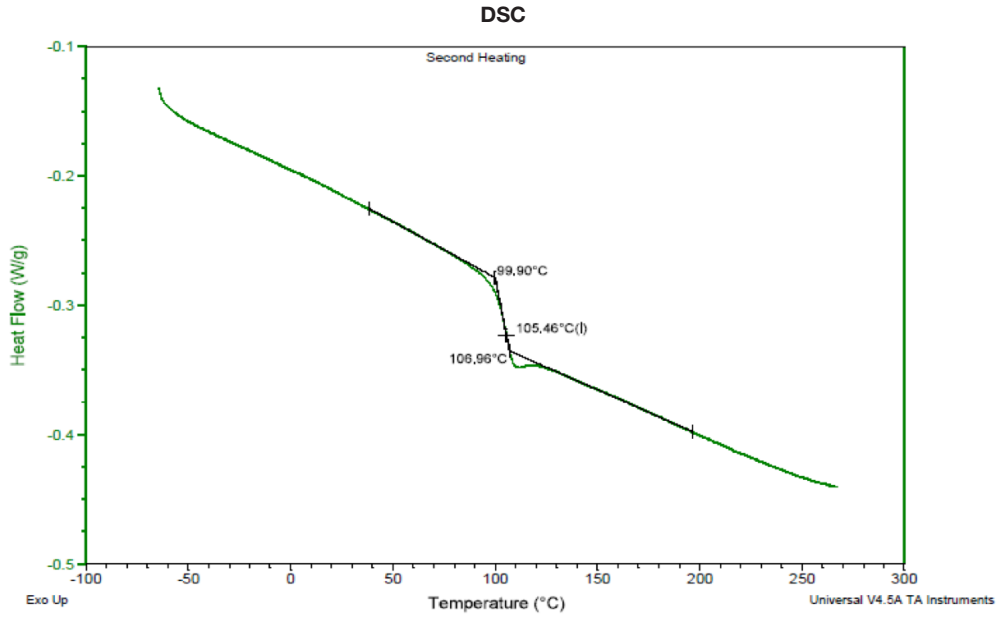


Figure 6. 2nd heating scan DSC data for the ABS-ESD7 Flat (XY) sample.



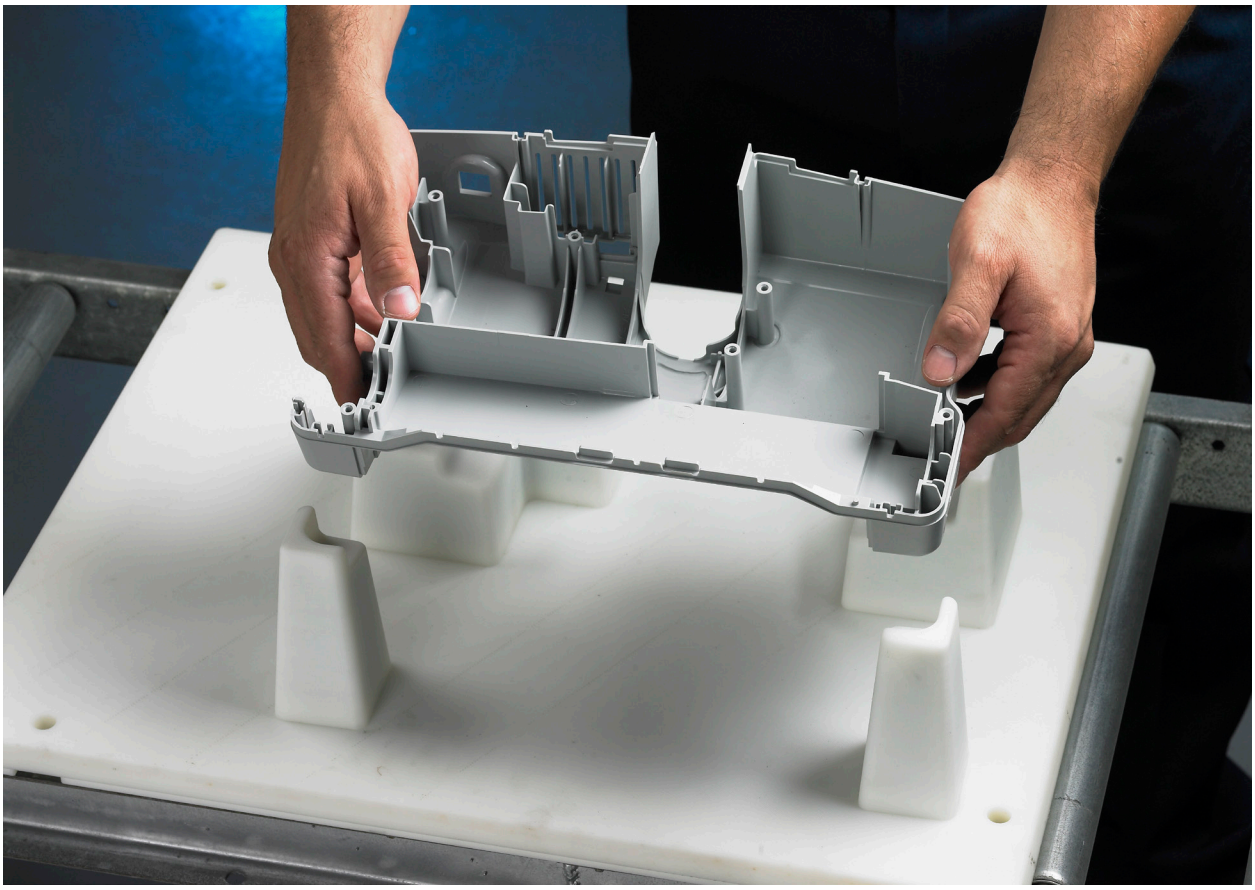
Stratasys Headquarters

7665 Commerce Way,
Eden Prairie, MN 55344
+1 800 801 6491 (US Toll Free)
+1 952 937-3000 (Intl)
+1 952 937-0070 (Fax)

1 Holtzman St., Science Park,
PO Box 2496
Rehovot 76124, Israel
+972 74 745 4000
+972 74 745 5000 (Fax)

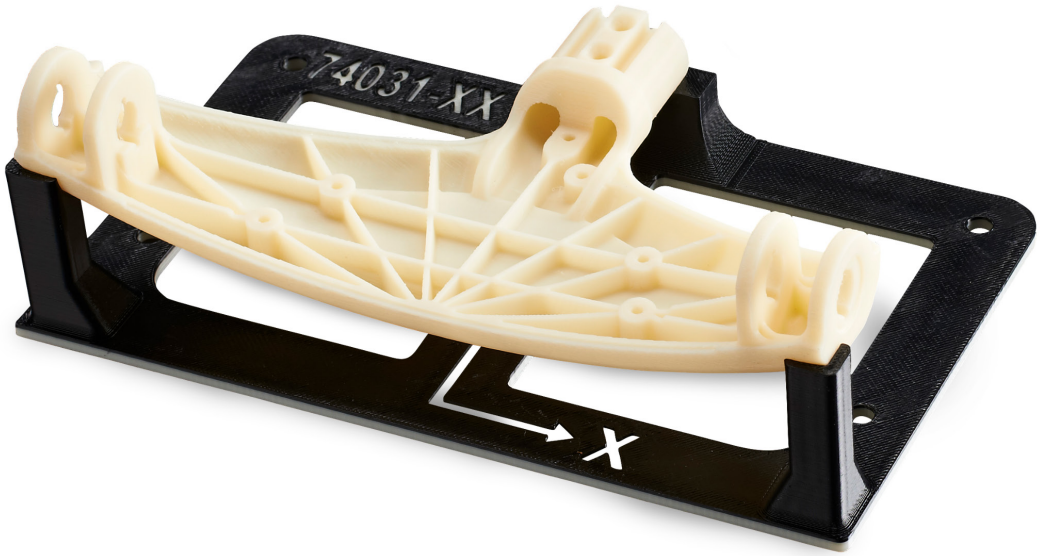
stratasys.com
ISO 9001:2015 Certified

ABS-M30



FDM Thermoplastic Filament

The information presented are typical values intended for reference and comparison purposes only.
They should not be used for design specifications or quality control purposes.



Overview

ABS-M30™ filament combines the design freedom of FDM® technology with the versatility and capability of ABS (acrylonitrile butadiene styrene). ABS is characterized by its strength and toughness, while being lightweight and resilient, suitable for most general-purpose 3D printing use cases.

Contents:

Ordering Information 3
Physical Properties 5
Mechanical Properties 6
Appendix 9

Ordering Information

Table 1. Printer and Support Material Compatibility

Printer	Model Tip (Slice)	Support Material	Support Tip
F120™	F123 Head (7, 10, 13 slice)	SR-30 (soluble)	F123 Head (all slices)
F170™	F123 Head (5, 7, 10, 13 slice)	QSR Support™ (soluble)	F123 Head (all slices)
F270™	F123 Head (5, 7, 10, 13 slice)	QSR Support (soluble)	F123 Head (all slices)
F370™	F123 Head (5, 7, 10, 13 slice)	QSR Support (soluble)	F123 Head (all slices)
F770™	F123 Head (7, 10, 13 slice)	SR-30 (soluble)	F123 Head (all slices)
Fortus 450mc™	T10 (5 slice) T12 (7 slice) T16 (10 slice) T20 (13 slice)	SR-30 / 35 (soluble)	T12SR30 (all slices)
Fortus 900mc™/F900™	T12 (7 slice) T16 (10 slice) T20 (13 slice)	SR-20 / 30 / 35 (soluble)	T12SR20 / 30 (all slices)

Build Sheet

Low Temperature

- 0.02 x 26 x 38 in. (0.51 x 660 x 965 mm)
- 0.02 x 16 x 18.5 in. (0.51 x 406 x 470 mm)

F770 Build Sheets

- 0.01 x 30 x 41 in. (0.254 x 762 x 1041 mm)

Table 2. Consumable Ordering Information

Part Number	Description
Printer Consumables	
123-00401-S	F370 Extrusion Head, all layer heights
511-10501	T10
511-10301	T12
511-10401	T16
511-10701	T20
511-10900	T12SR30
511-10901	T12SR20
123-00302-S	F120/F170 Build Tray
123-00303	F270 Build Tray, Standard
123-00304	F370 Build Tray, Standard
123-50100	F770 Build sheet, 0.01 x 30 x 41 in. (0.254 x 762 x 1041 mm), box of 20
325-00300	Low Temperature build sheet, 0.02x26x38 in. (0.51x660x965 mm)
325-00100	Low Temperature build sheet, 0.02x16x18.5 in. (0.51x406x470 mm)
310-00100	Low Temperature build sheet, 0.03x16x18.5 in. (0.76x406x470 mm)
355-00100	Low Temperature build sheet, 0.02x14x16.5 in (0.51x355x420 mm)

Table 3. ABS-M30 Ordering Information

Part Number	Description
Filament Canisters [1] [2]	
355-02110	ABS-M30 (Ivory), 92.3 cu in - Plus
355-02111	ABS-M30 (White), 92.3 cu in - Plus
355-02112	ABS-M30 (Black), 92.3 cu in - Plus
355-02113	ABS-M30 (Gray), 92.3 cu in - Plus
355-02114	ABS-M30 (Red), 92.3 cu in - Plus
355-02115	ABS-M30 (Blue), 92.3 cu in - Plus
355-02116	ABS-M30 (Nectarine), 92.3 cu in - Plus
355-02117	ABS-M30 (Yellow), 92.3 cu in - Plus
355-08110	ABS-M30 (Ivory), 184 cu in - Plus
355-08112	ABS-M30 (Black), 184 cu in - Plus
355-02120	ABS-M30i, 92.3 cu in - Plus
360-50110	ABS-M30 (Ivory), 500 cu in - Xtend
360-50211	ABS-M30 (Black), 500 cu in - Xtend
333-60300	ABS-M30 (Ivory), 60 cu in - F123
333-60301	ABS-M30 (Black), 60 cu in - F123
333-60302	ABS-M30 (White), 60 cu in - F123
333-60303	ABS-M30 (Red), 60 cu in - F123
333-60304	ABS-M30 (Blue), 60 cu in - F123
333-60305	ABS-M30 (Green), 60 cu in - F123
333-60306	ABS-M30 (Yellow), 60 cu in - F123
333-60307	ABS-M30 (Orange), 60 cu in - F123
333-60308	ABS-M30 (Dark Gray), 60 cu in - F123
333-90300	ABS-M30 (Ivory), 90 cu in - F123
333-90301	ABS-M30 (Black), 90 cu in - F123
333-90302	ABS-M30 (White), 90 cu in - F123
333-90308	ABS-M30 (Dark Gray), 90 cu in - F123
311-20000	ABS-M30 (Ivory) 92.3 cu in - Classic
311-20018	ABS-M30 (Natural) 184 cu in - Classic
311-20100	ABS-M30 (White) 92.3 cu in - Classic
311-20200	ABS-M30 (Black) 92.3 cu in - Classic
311-20218	ABS-M30 (Black) 184 cu in - Classic
311-20300	ABS-M30 (Gray) 92.3 cu in - Classic
311-20400	ABS-M30 (Red) 92.3 cu in - Classic
311-20500	ABS-M30 (Blue) 92.3 cu in - Classic
311-21400	ABS-M30i, 92.3 cu in - Classic
331-20307	ABS (Black), 200 cu in., long lead - F770
355-03110	SR-30 Soluble Support, 92.3 cu in - Plus
360-53110	Xtend SR-30 Soluble Support, 500 cu in - Plus
310-30500	SR-20 Soluble Support, 92.3 cu in - Classic
311-30200	SR-30 Soluble Support, 92.3 cu in - Classic
331-20200	SR-30 Soluble Support, 200 cu in - F120
331-20207	SR30 Soluble Support, 200 cu in., long lead - F770
355-03135	SR-35 Soluble Support, 92.3 cu in - Plus
311-30235	SR-35 Soluble Support, 92.3 cu in - Classic
333-63500	QSR Soluble Support, 60 cu in - F123

[1] Classic canisters are compatible with all Fortus 900mc printers prior to s/n L502.

[2] Plus canisters are compatible with all Fortus 450mc, all Stratasys F900, and Fortus 900mc printers s/n L502 and up.

Physical Properties

Values are measured as printed. XY, XZ, and ZX orientations were tested. For full details refer to the Stratasys Materials Test Report (immediate download upon clicking the link). DSC and TMA curves can be found in the Appendix.

Table 4. ABS-M30 Physical Properties

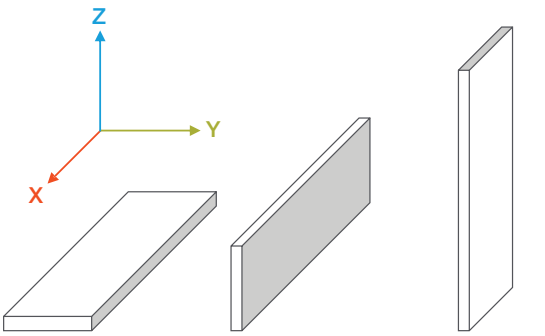
Property	Test Method	Typical Values	
		XY	XZ/ZX
HDT @ 66 psi	ASTM D648 Method B	103.8 C (218.9 F)	
HDT @ 264 psi	ASTM D648 Method B	99.9 C (211.7 F)	
Tg	ASTM D7426 Inflection Point	105.2 C (221.4 F)	
Mean CTE	ASTM E831 (40 °C to 140 °C)	60.77 µm/[m*°C] (33.76 µin./[in.*°F])	
Mean CTE	ASTM E831 (40 °C to 80 °C)		58.65 µm/[m*°C] 32.58 µin/[in*°F]
Volume Resistivity	ASTM D257	> 6.75*10^14 Ω*cm	
Dielectric Constant	ASTM D150 1 kHz test condition	2.64	2.78
Dielectric Constant	ASTM D150 2 MHz test condition	2.49	2.61
Dissipation Factor	ASTM D150 1 kHz test condition	0.003	0.005
Dissipation Factor	ASTM D150 2 MHz test condition	0.004	0.007
Specific Gravity	ASTM D257 @23 °C	1.05	

Mechanical Properties

ABS-M30 black samples were printed with 0.010 in. (0.254 mm) layer heights on the F900 and F770. For the full test procedure please see the Stratasys Materials Test Procedure (immediate download upon clicking the link).

Print Orientation

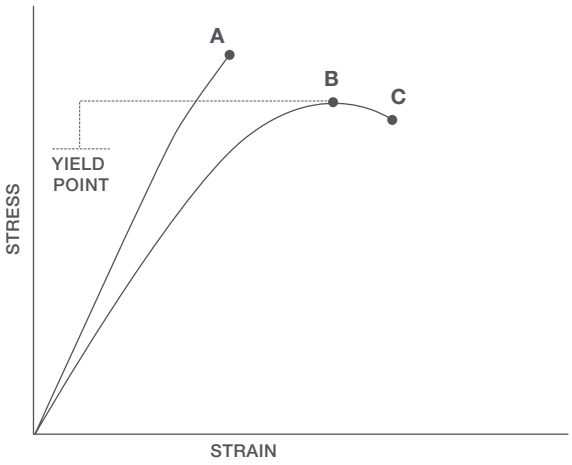
Parts created using FDM are anisotropic as a result of the printing process. Below is a reference of the different orientations used to characterize the material.



Flat (XY) On Edge (XZ) Upright (ZX)

Tensile Curves

Due to the anisotropic nature of FDM, tensile curves look different depending on orientation. Below is a guide of the two types of curves seen when printing tensile samples and what reported values mean.



A = Tensile at break, elongation at break (no yield point)
B = Tensile at yield, elongation at yield
C = Tensile at break, elongation at break

Table 5. ABS-M30 Mechanical Properties (F900 - T16 Tip)

		XZ Orientation[1]	ZX Orientation[1]
Tensile Properties: ASTM D638			
Yield Strength	MPa	30.8 (0.85)	27.5 (0.28)
	psi	4470 (120)	3990 (41)
Elongation @ Yield	%	1.8 (0.043)	1.7 (0.13)
Strength @ Break	MPa	28.1 (0.58)	26.8 (0.84)
	psi	4080 (84)	3890 (120)
Elongation @ Break	%	8.1 (1.5)	1.8 (0.31)
Modulus (Elastic)	GPa	2.40 (0.080)	2.30 (0.16)
	ksi	349 (12)	334 (23)
Flexural Properties: ASTM D790, Procedure A			
Strength @ Break	MPa	No break	47.7 (2.2)
	psi	No break	6910 (320)
Strength @ 5% Strain	MPa	58.7 (0.54)	-
	psi	8510 (78)	-
Strain @ Break	%	No break	3.4 (0.22)
Modulus	GPa	2.22 (0.037)	1.96 (0.064)
	ksi	323 (5.4)	284 (9.3)
Compression Properties: ASTM D695			
Yield Strength	MPa	88.3 (3.0)	208 (15)
	psi	12800 (440)	30100 (2200)
Modulus	GPa	2.20 (0.11)	2.16 (0.092)
	ksi	319 (17)	314 (13)
Impact Properties: ASTM D256, ASTM D4812			
Notched	J/m	101 (9.9)	32.2 (3.0)
	ft*lb/in.	1.89 (0.19)	0.603 (0.057)
Unnotched	J/m	291 (57)	103 (30)
	ft*lb/in.	5.45 (1.1)	1.93 (0.57)

(1) Values in parentheses are standard deviations.

Table 6. ABS-M30 Mechanical Properties (F770)

		XZ Orientation[1]	ZX Orientation[1]
Tensile Properties: ASTM D638			
Yield Strength	MPa	32.5 (1.7)	23.1 (1.3)
	psi	4720 (250)	3350 (190)
Elongation @ Yield	%	2.1 (0.1)	1.6 (0.2)
Strength @ Break	MPa	27.6 (2.4)	22.9 (1.2)
	psi	4000 (350)	3310 (170)
Elongation @ Break	%	4.5 (1.2)	1.6 (0.2)
Modulus (Elastic)	GPa	2.00 (27)	1.78 (29)
	ksi	290 (3.9)	258 (4.1)
Flexural Properties: ASTM D790, Procedure A			
Strength @ Break	MPa	No Break	37.8 (4.1)
	psi	No Break	5480 (590)
Strength @ 5% Strain	MPa	58.1 (2.2)	-
	psi	8430 (320)	-
Strain @ Break	%	No Break	2.2 (0.3)
Modulus	GPa	2.17 (0.03)	1.84 (0.06)
	ksi	315 (4.9)	267 (8.1)
Impact Properties: ASTM D256, ASTM D4812			
Notched	J/m	91.0 (17)	21.7 (3.7)
	ft*lb/in	1.71 (0.31)	0.406 (0.07)
Unnotched	J/m	423 (96)	62.9 (134)
	ft*lb/in	7.92 (1.8)	1.18 (0.3)

(1) Values in parentheses are standard deviations.

Appendix

Figure 1. 2nd heating scan DSC data for the ABS-M30 Black Flat (XY) sample.

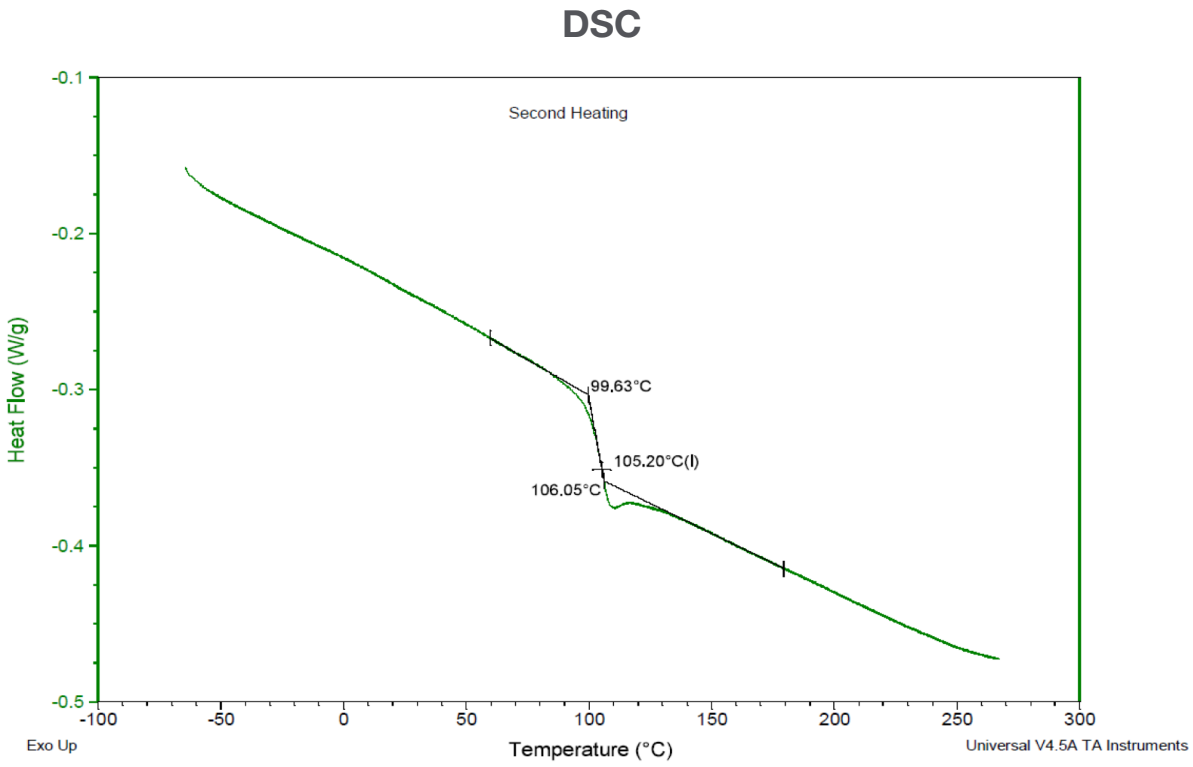


Figure 2. Dimension change data as a function of temperature for the ABS-M30 Black Flat (XY) sample.

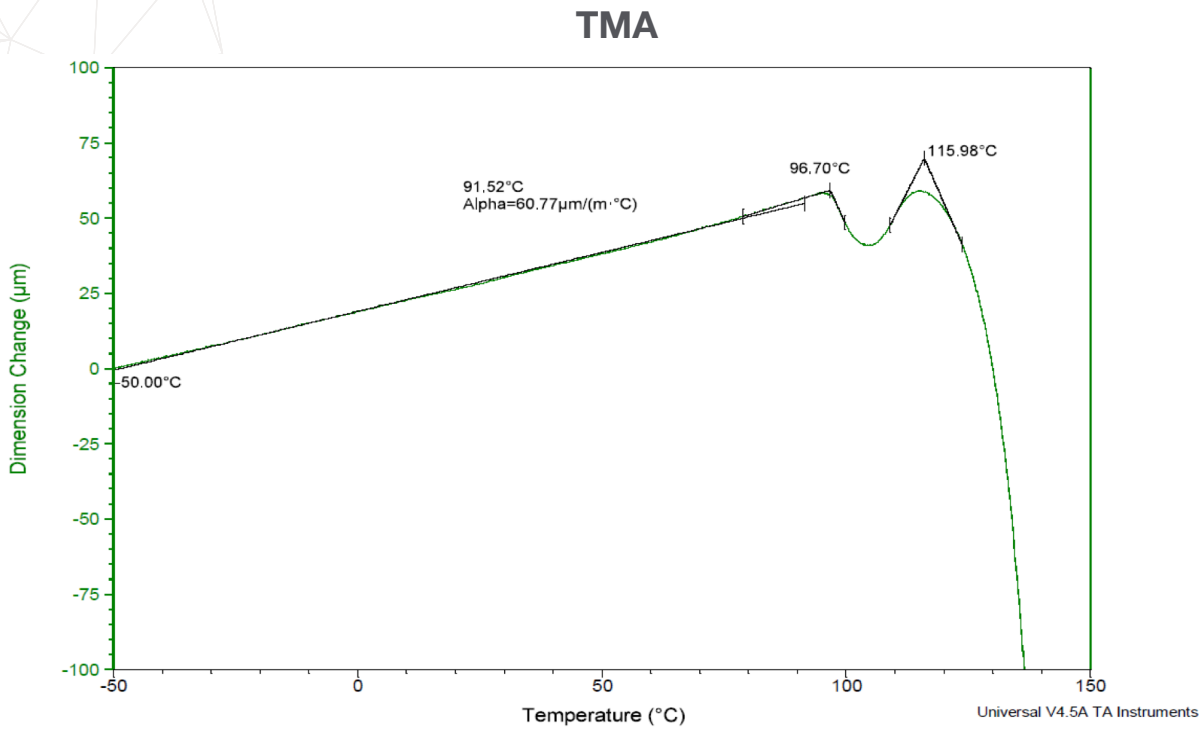


Figure 3. Dimension change data as a function of temperature for the ABS-M30 Black On Edge (XZ) sample.

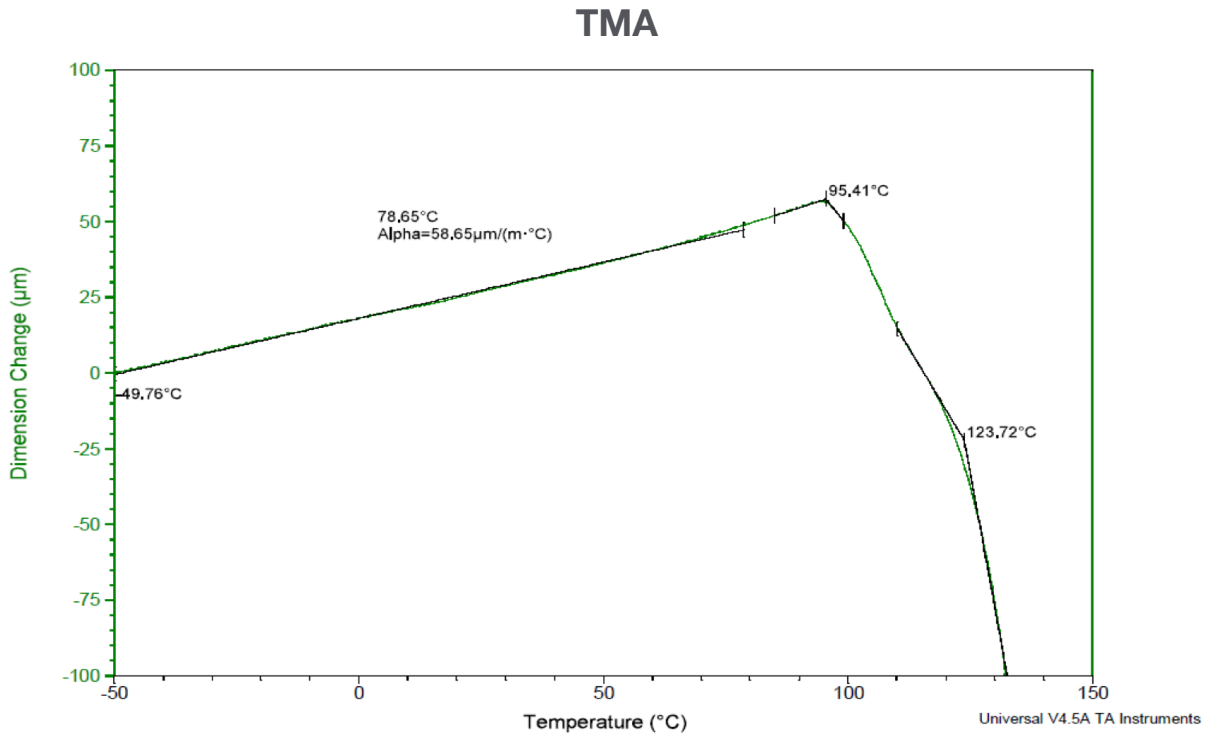
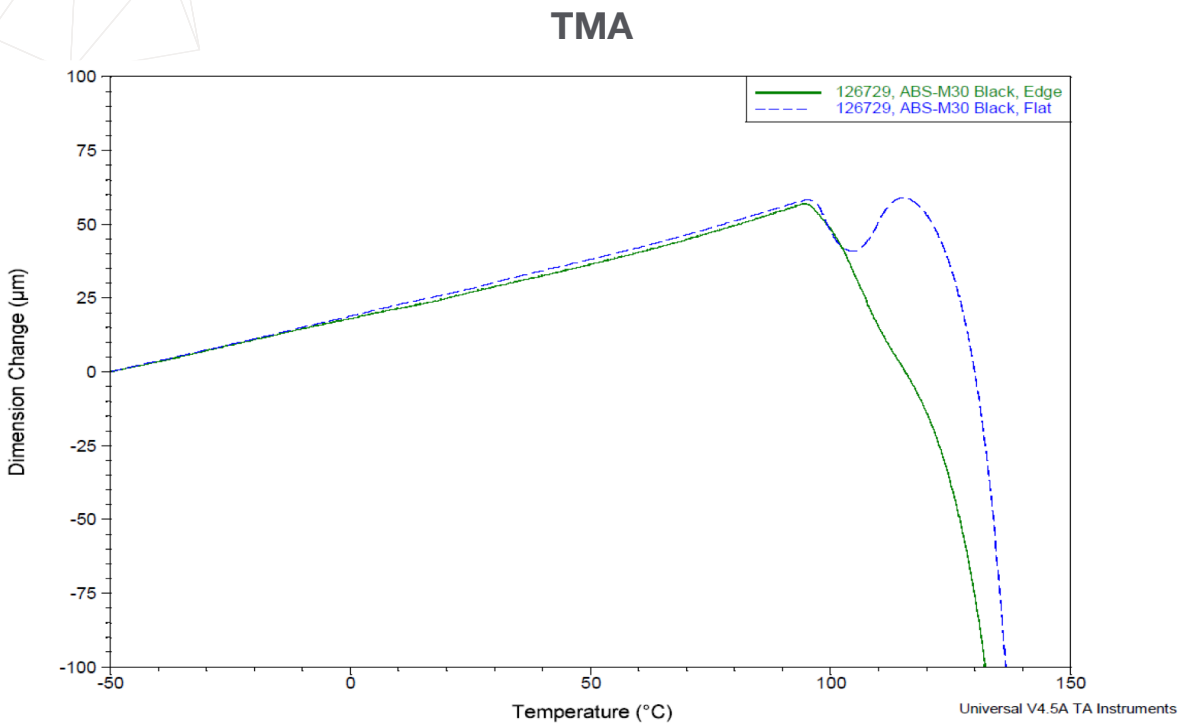


Figure 4. Overlay of the dimension change data for the Flat (XY) and On Edge (XZ) ABS-M30 Black samples.



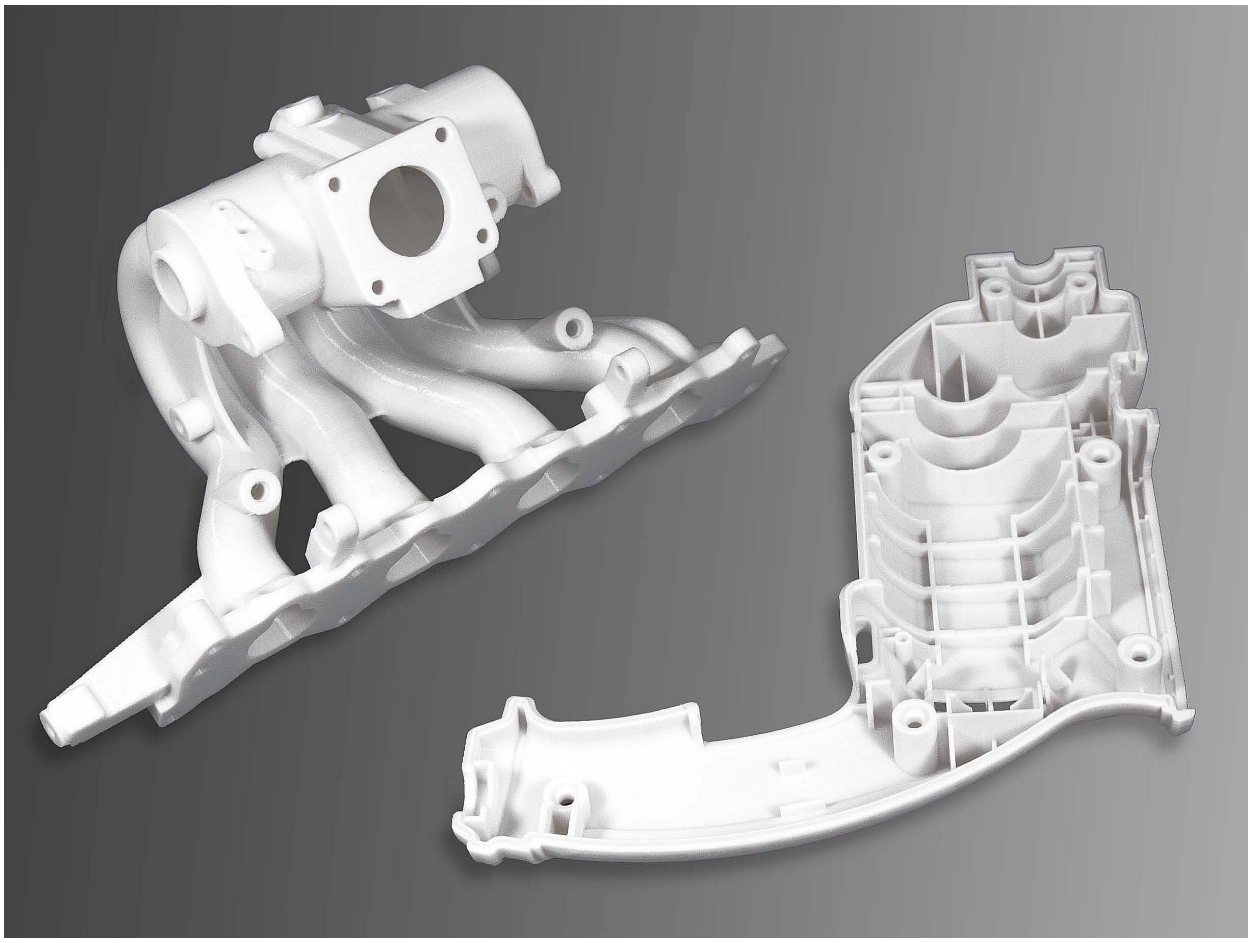
Stratasys Headquarters

7665 Commerce Way,
Eden Prairie, MN 55344
+1 800 801 6491 (US Toll Free)
+1 952 937-3000 (Intl)
+1 952 937-0070 (Fax)

1 Holtzman St., Science Park,
PO Box 2496
Rehovot 76124, Israel
+972 74 745 4000
+972 74 745 5000 (Fax)

stratasys.com
ISO 9001:2015 Certified

PC (Polycarbonate)



FDM Thermoplastic Filament

The information presented are typical values intended for reference and comparison purposes only.
They should not be used for design specifications or quality control purposes.

Overview

PC is a polycarbonate FDM® filament that brings the attributes of this industrial plastic to 3D printing applications. PC is characterized by its high strength and impact resistance, coupled with dimensional stability and heat resistance. These attributes make it a good choice for 3D printed prototypes, parts and tools that demand higher material properties than ABS or ASA.

FDM PC is available in white and is compatible with both breakaway and soluble support materials.

Contents:

Ordering Information 3
Physical Properties 5
Mechanical Properties 6
Appendix 8

Ordering Information

Table 1. Printer and Support Material Compatibility

Printer	Model Tip (Slice)	Support Material	Support Tip
Fortus 450mc™	T10 (5 slice) T12 (7, 10 slice) T16 (10 slice) T20 (13 slice)	SR-100 (soluble) (5, 7, 10 slice) PC BASS (breakaway) (7, 10, 13 slice)	T12SR100 (SR-100) (5, 7, 10 slice) T12 (PC BASS) (7 slice) T16 (PC BASS) (10, 13 slice)
Fortus 900mc™/F900™	T12 (7, 10 slice) T16 (10 slice) T20 (13 slice)	SR-100 (soluble) (7, 10, 13 slice) PC BASS (breakaway) (7, 10, 13 slice)	T12SR100 (SR-100) (7, 10, 13 slice) T12 (PC BASS) (7 slice) T16 (PC BASS) (10, 13 slice)

BASS = breakaway support system.

Build Sheet

Low Temperature

- 0.02 x 26 x 38 in. (0.51 x 660 x 965 mm)
- 0.02 x 16 x 18.5 in. (0.51 x 406 x 470 mm)

Table 2. PC Ordering Information

Part Number	Description
Filament Canisters[1] [2]	
355-02210	PC, 92.3 cu in. - Plus
355-08210	PC, 184 cu in. - Plus
360-50210	PC, Xtend 500 - Plus
310-20100	PC, 92.3 cu in. - Classic
310-20118	PC, 184 cu in. - Classic
355-03210	PC BASS, 92.3 cu in. - Plus
360-53210	PC BASS, Xtend 500 - Plus
310-30100	PC BASS, 92.3 cu in. - Classic
355-03120	SR-100 Soluble Support, 92.3 - Plus
310-31100	SR-100 Soluble Support, 92.3 - Classic
Printer Consumables	
511-10501	T10 tip
511-10301	T12 tip
511-10401	T16 tip
511-10701	T20 tip
511-10100	T12SR100 tip, 0.005, 0.007, and 0.010 in. support layer heights
325-00300	Low Temperature build sheet, 0.02x26x38 in. (0.51x660x965 mm)
325-00100	Low Temperature build sheet, 0.02x16x18.5 in. (0.51x406x470 mm)
310-00100	Low Temperature build sheet, 0.03x16x18.5 in. (0.76x406x470 mm)
355-00100	Low Temperature build sheet, 0.02x14x16.5 in. (0.51x355x420 mm)

[1] Classic canisters are compatible with all Fortus 900mc printers prior to s/n L502.

[2] Plus canisters are compatible with all Fortus 450mc, all Stratasys F900, and Fortus 900mc printers s/n L502 and up.

Physical Properties

Values are measured as printed. XY, XZ, and ZX orientations were tested. For full details refer to the Stratasys Materials Test Report (immediate download upon clicking the link). DSC and TMA curves can be found in the Appendix.

Table 3. PC Physical Properties

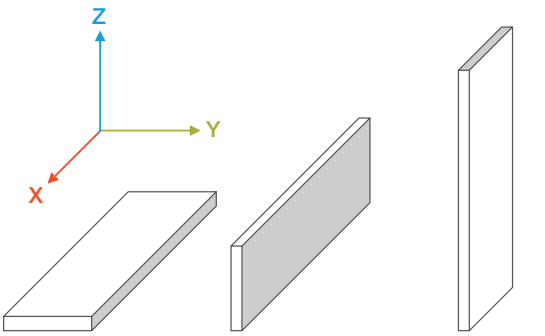
Property	Test Method	Typical Values	
		XY	XZ/ZX
HDT @ 66 psi	ASTM D648 Method B	143.7 C (290.7 F)	
HDT @ 264 psi	ASTM D648 Method B	142.2 C (288.0 F)	
Tg	ASTM D7426 Inflection Point	142.53 C (288.55 F)	
Mean CTE	ASTM E831 (-50 °C to 120 °C)	-	49.19 µm/[m*°C] (27.33 µin/[in*°F])
	ASTM E831 (-50 vC to 30 °C)	51.64 µm/[m*°C] (28.69 µin/[in*°F])	-
	ASTM E831 (30 °C to 75 °C)	35.79 µm/[m*°C] (19.88 µin/[in*°F])	-
	ASTM E831 (75 °C to 130 °C)	11.51 µm/[m*°C] (6.394 µin/[in*°F])	-
Volume Resistivity	ASTM D257	> 6.78*10^14 Ω*cm	
Dielectric Constant	ASTM D150 1 kHz test condition	2.66	2.84
	ASTM D150 2 MHz test condition	2.53	2.69
Dissipation Factor	ASTM D150 1 kHz test condition	-0.002	-0.002
	ASTM D150 2 MHz test condition	0.003	0.008
Thermal Conductivity	ASTM E1952 @0C	0.2802 W/m*K 0.1619 BTU/(hr*ft*F)	
Thermal Conductivity	ASTM E1952 @30C	0.2845 W/m*K 0.1644 BTU/(hr*ft*F)	
Thermal Conductivity	ASTM E1952 @60C	0.2902 W/m*K 0.1677 BTU/(hr*ft*F)	
Thermal Conductivity	ASTM E1952 @90C	0.2888 W/m*K 0.1669 BTU/(hr*ft*F)	
Thermal Diffusivity	ASTM E1952 @0C	0.189 mm^2/s 2.93*10^-4 in^2/s	
Thermal Diffusivity	ASTM E1952 @30C	0.171 mm^2/s 2.65*10^-4 in^2/s	
Thermal Diffusivity	ASTM E1952 @60C	0.159 mm^2/s 2.46*10^-4 in^2/s	
Thermal Diffusivity	ASTM E1952 @90C	0.146 mm^2/s 2.26*10^-4 in^2/s	
Specific Gravity	ASTM D257 @23 °C	1.20	

Mechanical Properties

PC samples were printed with 0.010 in. (0.254 mm) layer heights on the F900. For the full test procedure please see the Stratasys Materials Test Procedure (immediate download upon clicking the link).

Print Orientation

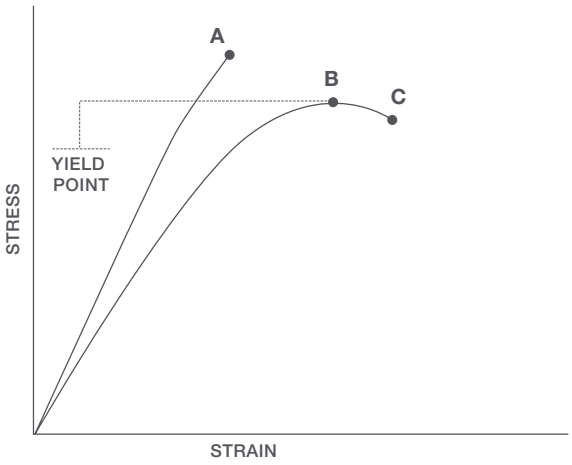
Parts created using FDM are anisotropic as a result of the printing process. Below is a reference of the different orientations used to characterize the material.



Flat (XY) On Edge (XZ) Upright (ZX)

Tensile Curves

Due to the anisotropic nature of FDM, tensile curves look different depending on orientation. Below is a guide of the two types of curves seen when printing tensile samples and what reported values mean.



A = Tensile at break, elongation at break (no yield point)
B = Tensile at yield, elongation at yield
C = Tensile at break, elongation at break

Table 4. PC Mechanical Properties (F900 - T16 Tip)

		XZ Orientation[1]	ZX Orientation[1]
Tensile Properties: ASTM D638			
Yield Strength	MPa	57.9 (1.6)	No yield
	psi	8390 (240)	No yield
Elongation @ Yield	%	4.9 (0.12)	No yield
Strength @ Break	MPa	57.3 (1.6)	35.5 (9.0)
	psi	8310 (240)	5150 (1300)
Elongation @ Break	%	5.2 (0.38)	2.0 (0.63)
Modulus (Elastic)	GPa	2.25 (0.050)	2.13 (0.11)
	ksi	327 (7.3)	310 (16)
Flexural Properties: ASTM D790, Procedure A			
Strength @ Break	MPa	No break	75.0 (5.4)
	psi	No break	10900 (780)
Strength @ 5% Strain	MPa	90.0 (1.7)	-
	psi	13100 (240)	-
Strain @ Break	%	No break	4.58 (0.41)
Modulus	GPa	2.15 (0.042)	1.88 (0.071)
	ksi	312 (6.1)	273 (10)
Compression Properties: ASTM D695			
Yield Strength	MPa	244 (13)	290 (19)
	psi	35400 (1900)	42100 (2800)
Modulus	GPa	1.95 (0.051)	2.11 (0.090)
	ksi	283 (7.4)	306 (13)
Impact Properties: ASTM D256, ASTM D4812			
Notched	J/m	76.8 (11)	26.9 (7.7)
	ft*lb/in.	1.44 (0.21)	0.503 (0.14)
Unnotched	J/m	761 (110)	233 (70)
	ft*lb/in.	14.2 (2.0)	4.36 (1.3)

[1] Values in parentheses are standard deviations.

Appendix

Figure 1. 2nd heating scan DSC data for the PC Flat (XY) sample.

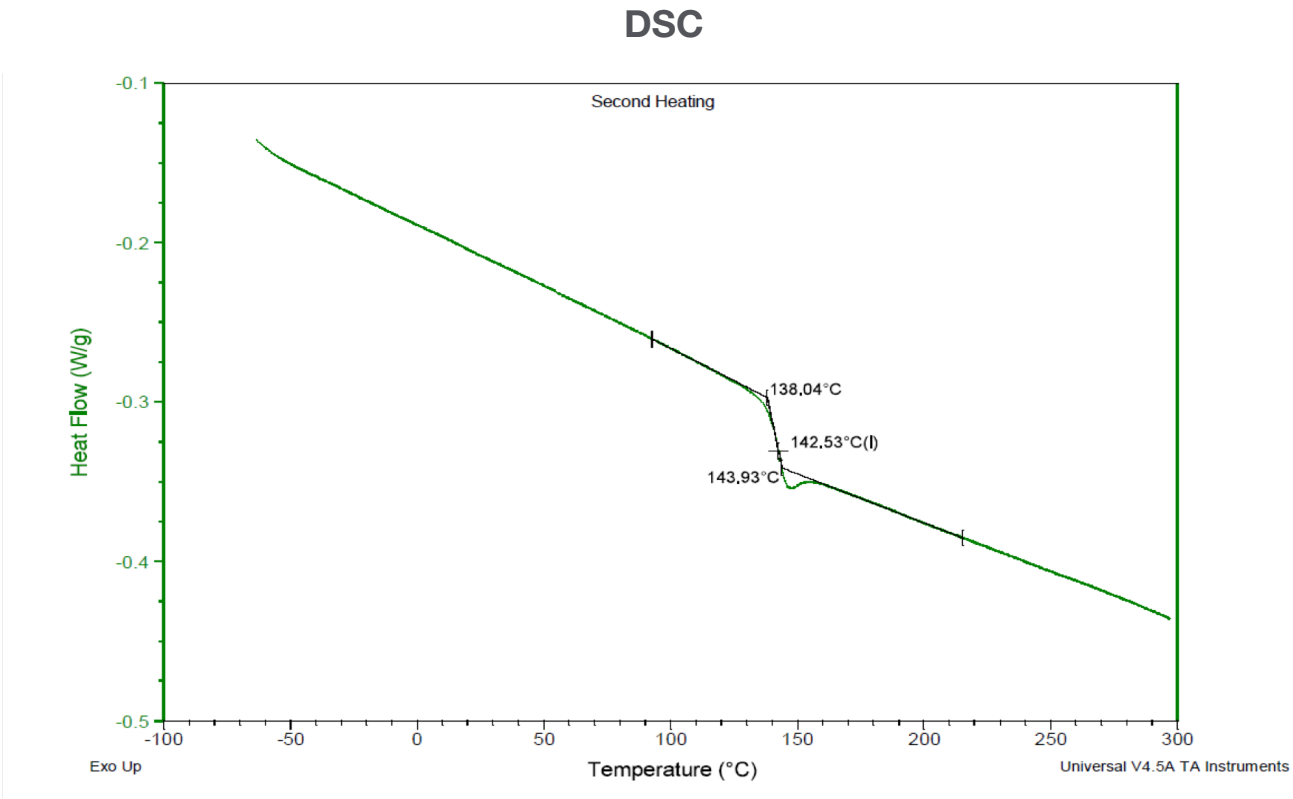


Figure 2. Dimension change data as a function of temperature for the PC Flat (XY) sample.

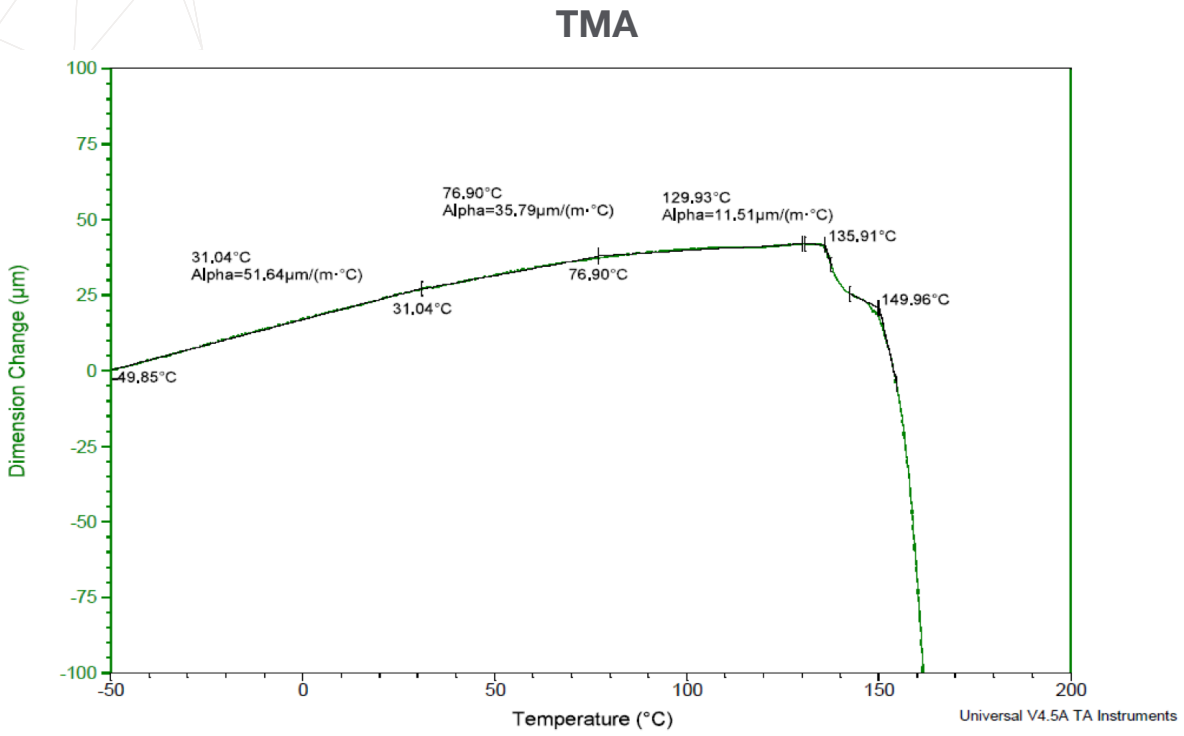


Figure 3. Dimension change data as a function of temperature for the PC On Edge (XZ) sample.

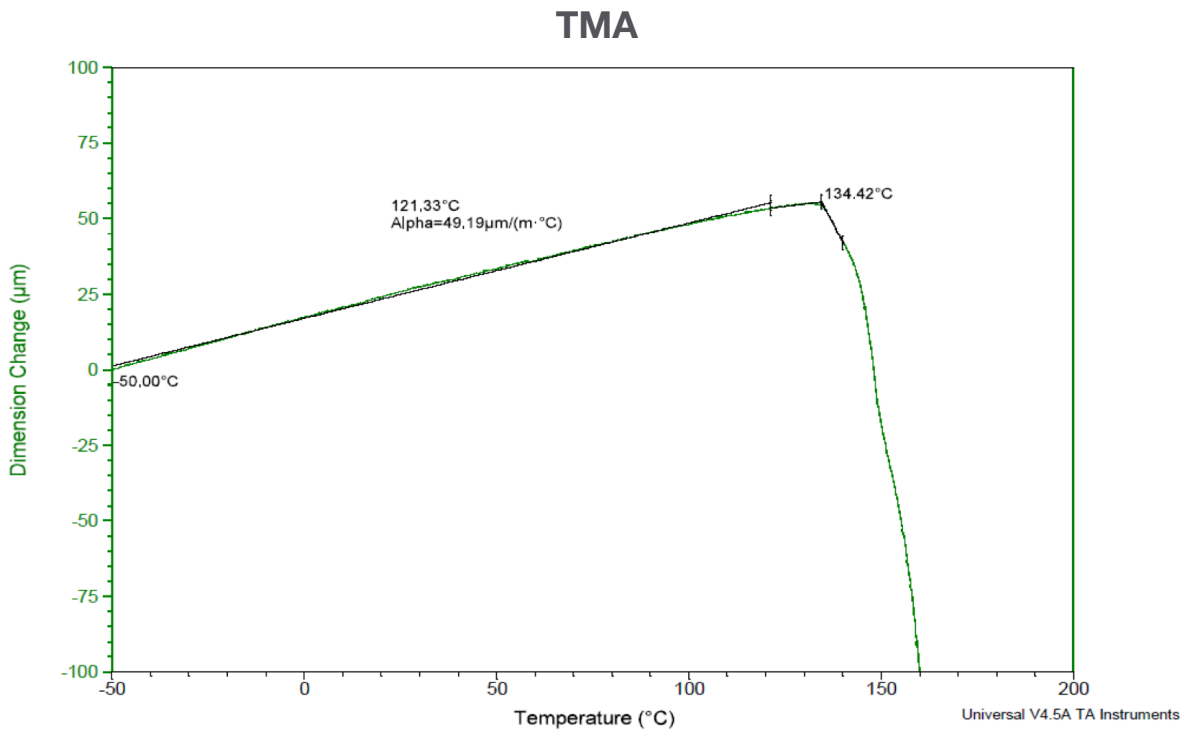
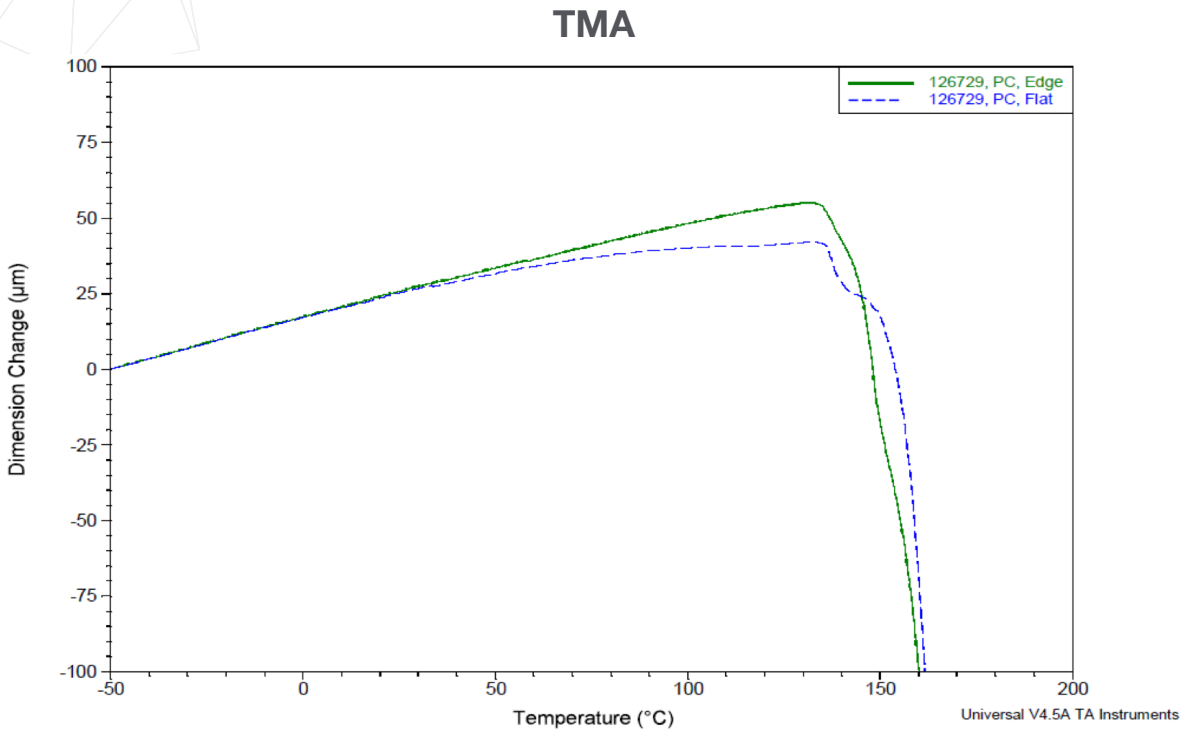


Figure 4. Overlay of the dimension change data for the Flat (XY) and On Edge (XZ) PC samples.



Stratasys Headquarters

7665 Commerce Way,
Eden Prairie, MN 55344
+1 800 801 6491 (US Toll Free)
+1 952 937-3000 (Intl)
+1 952 937-0070 (Fax)

1 Holtzman St., Science Park,
PO Box 2496
Rehovot 76124, Israel
+972 74 745 4000
+972 74 745 5000 (Fax)

stratasys.com
ISO 9001:2015 Certified

PC-ISO

PC-ISO (polycarbonate-ISO), an industrial thermoplastic, which in its raw state, is biocompatible (ISO 10993 USP Class VI)* and can be gamma or EtO sterilized. PC-ISO is commonly used in food and drug packaging and medical device manufacturing because of the material's strength and medical compatibility. When combined with a Fortus® 3D Printer, PC-ISO gives you parts that can be used for conceptual modeling, functional prototyping, and production parts.

Mechanical Properties[1]	Test Method	Value
Tensile Strength (Type 1, 0.125", 0.2"/min)	ASTM D638	57 MPa (8,300 psi)
Tensile Modulus (Type 1, 0.125", 0.2"/min)	ASTM D638	2,000 MPa (289,800 psi)
Tensile Elongation (Type 1, 0.125", 0.2"/min)	ASTM D638	4% (4%)
Flexural Strength (Method 1, 0.05"/min)	ASTM D790	90 MPa (13,100 psi)
Flexural Modulus (Method 1, 0.05"/min)	ASTM D790	2,100 MPa (310,400 psi)
IZOD Impact, notched (Method A, 23 °C)	ASTM D256	86 J/m (1.6 ft-lb/in)
IZOD Impact, un-notched (Method A, 23 °C)	ASTM D256	53 J/m (1 ft-lb/in)

Thermal Properties[2]	Test Method	Value
Heat Deflection (HDT) @ 66 psi	ASTM D648	133 °C (271 °F)
Heat Deflection (HDT) @ 264 psi	ASTM D648	127 °C (260 °F)
Glass Transition (Tg)	DMA (SSYS)	161 °C (322 °F)
Vicat Softening	ISO 306	139 °C (282 °F)
Melting Point	----------	Not Applicable[3] (Not Applicable[3])

Electrical Properties[4]	Test Method	Value Range
Volume Resistivity	ASTM D257	1.5x1014 - 8.0x1013 ohm-cm
Dielectric Constant	ASTM D150-98	3.0 - 2.8
Dissipation Factor	ASTM D150-98	.0009 - .0005
Dielectric Strength	ASTM D149-09, Method A	370 - 70 V/mil

PC-ISO

Other[2]	Test Method	Value
Specific Gravity	ASTM D792	1.2

System Availability	Layer Thickness Capability	Support Structure	Available Colors
Fortus 380mc™ Fortus 400mc™ Fortus 450mc™ Fortus 900mc™ F900™	0.013 inch (0.330 mm) 0.010 inch (0.254 mm) 0.007 inch (0.178 mm)	Breakaway	Translucent Natural White

The information presented are typical values intended for reference and comparison purposes only. They should not be used for design specifications or quality control purposes. End-use material performance can be impacted (+/-) by, but not limited to, part design, end-use conditions, test conditions, etc. Actual values will vary with build conditions. Tested parts were built on Fortus 400mc™ @ 0.010" (0.254 mm) slice. Product specifications are subject to change without notice.

The performance characteristics of these materials may vary according to application, operating conditions, or end use. Each user is responsible for determining that the Stratasys material is safe, lawful, and technically suitable for the intended application, as well as for identifying the proper disposal (or recycling) method consistent with applicable environmental laws and regulations. Stratasys makes no warranties of any kind, express or implied, including, but not limited to, the warranties of merchantability, fitness for a particular use, or warranty against patent infringement.

*It is the responsibility of the finished device manufacturer to determine the suitability of all the component parts and materials used in their finished products.

[1]Build orientation is on side long edge.

[2]Literature value unless otherwise noted.

[3]Due to amorphous nature, material does not display a melting point.

[4]All Electrical Property values were generated from the average of test plaques built with default part density (solid). Test plaques were 4.0 x 4.0 x 0.1 inches (102 x 102 x 2.5 mm) and were built both in the flat and vertical orientation. The range of values is mostly the result of the difference in properties of test plaques built in the flat vs. vertical orientation.

Stratasys Headquarters

7665 Commerce Way,
Eden Prairie, MN 55344
+1 800 801 6491 (US Toll Free)
+1 952 937-3000 (Intl)
+1 952 937-0070 (Fax)

1 Holtzman St., Science Park,
PO Box 2496
Rehovot 76124, Israel
+972 74 745 4000
+972 74 745 5000 (Fax)

stratasys.com
ISO 9001:2015 Certified

FDM Nylon 6

PRODUCTION-GRADE THERMOPLASTIC FOR FORTUS 3D PRINTERS

FDM Nylon 6™ combines strength and toughness superior to other FDM thermoplastics, for applications that require strong, customized parts and tooling that lasts longer and withstands rigorous functional testing.

Engineered with nylon 6, a popular thermoplastic for manufacturing, this material works with the Fortus 900mc™ to produce durable parts with a clean finish and high break resistance. FDM Nylon 6 is ideal for product manufacturers and development engineers in automotive, aerospace, consumer goods and industrial manufacturing.

CONDITIONED*

MECHANICAL PROPERTIES[1]	TEST METHOD	ENGLISH		METRIC	
		XZ Axis	*ZX Axis*	*XZ Axis*	*ZX Axis*
Tensile Strenth, Yield (Type 1, 0.125”, 0.2”/min)	ASTM D638	7,150 psi	4,200 psi	49.3 MPa	28.9 MPa
Tensile Strength, Ultimate (Type 1, 0.125”, 0.2”/min)	ASTM D638	9,800 psi	5,300 psi	67.6 MPa	36.5 MPa
Tensile Modulus (Type 1, 0.125”, 0.2”/min)	ASTM D638	323,700 psi	263,500 psi	2,232 MPa	1,817 MPa
Elongation at Break (Type 1, 0.125”, 0.2”/min)	ASTM D638	38%	3.2%	38%	3.2%
Elongation at Yield (Type 1, 0.125”, 0.2”/min)	ASTM D638	2.3%	1.7%	2.3%	1.7%
Flexural Strength (Method 1, 0.05”/min)	ASTM D790	14,100 psi	11,900 psi	97.2 MPa	82 MPa
Flexural Modulus (Method 1, 0.05”/min)	ASTM D790	318,500 psi	272,500 psi	2,196 MPa	1,879 MPa
Flexural Strain at Break	ASTM D790	No Break	No Break	No Break	No Break
IZOD impact - notched (Method A, 23 °C)	ASTM D256	2.0 ft-lb/in	0.8 ft-lb/in	106 J/m	43 J/m
IZOD impact - unnotched (Method A, 23 °C)	ASTM D256	53.8 ft-lb/in	3.6 ft-lb/in	2,873 J/m	192 J/m

FDM Nylon 6

PRODUCTION-GRADE THERMOPLASTIC FOR FORTUS 3D PRINTERS

At the core:
Advanced FDM Technology

FDM® (fused deposition modeling) technology works with engineering-grade thermoplastics to build strong, long-lasting and dimensionally stable parts with the best accuracy and repeatability of any 3D printing technology. These parts are tough enough to be used as advanced conceptual models, functional prototypes, manufacturing tools and production parts.

Meet production demands

FDM systems are as versatile and durable as the parts they produce. Advanced FDM 3D Printers boast the largest build envelopes and material capacities in their class, delivering longer, uninterrupted build times, bigger parts and higher quantities than other additive manufacturing systems, delivering high throughput, duty cycles and utilization rates.

Opening the way for new possibilities

FDM 3D Printers streamline processes from design through manufacturing, reducing costs and eliminating traditional barriers along the way. Industries can cut lead times and costs, products turn out better and get to market faster.

No special facilities needed

FDM 3D Printers are easy to operate and maintain compared to other additive fabrication systems because there are no messy powders or resins to handle and contain, and no special venting is required because FDM systems don't produce noxious fumes, chemicals or waste.

THERMAL PROPERTIES[1]	TEST METHOD	ENGLISH	METRIC
Heat Deflection (HDT) @ 264 psi	ASTM D648	199 °F	93 °C

SYSTEM AVAILABILITY	LAYER THICKNESS CAPABILITY	SUPPORT MATERIAL	COLOR
Fortus 900mc	0.010 inch (0.254 mm) 0.013 inch (0.330 mm)	SR-110	■ Black

**Conditioned = 20 °C and 50% RH for 40 hours*

The information presented are typical values intended for reference and comparison purposes only. They should not be used for design specifications or quality control purposes. End-use material performance can be impacted (+/-) by, but not limited to, part design, end-use conditions, test conditions, etc. Actual values will vary with build conditions. Tested parts were built on Fortus 400mc™ @ 0.010" (0.254 mm) slice. Product specifications are subject to change without notice.

The performance characteristics of these materials may vary according to application, operating conditions, or end use. Each user is responsible for determining that the Stratasys material is safe, lawful, and technically suitable for the intended application, as well as for identifying the proper disposal (or recycling) method consistent with applicable environmental laws and regulations. Stratasys makes no warranties of any kind, express or implied, including, but not limited to, the warranties of merchantability, fitness for a particular use, or warranty against patent infringement.

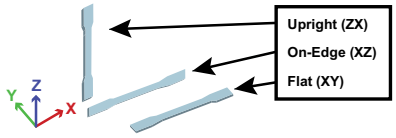
[1]Literature value unless otherwise noted.

Orientation: See Stratasys Testing white paper for more detailed description of build orien tations.

XZ = X or "on edge"

XY = Y or "flat"

ZX = or "upright"



stratasys

STRATASYS.COM

ISO 9001:2008 Certified

HEADQUARTERS
7665 Commerce Way, Eden Prairie, MN 55344
+1 888 480-3548 (US Toll Free)
+1 952 937-3000 (Intl)
+1 952 937-0070 (Fax)

1 Holtzman St., Science Park, PO Box 2496
Rehovot 76124, Israel
+972 74 745-4000
+972 74 745-5000 (Fax)

MSS_FDM_Nylon6_EN_1117a

FDM Nylon 12

FDM Thermoplastic Filament

The information presented are typical values intended for reference and comparison purposes only.
They should not be used for design specifications or quality control purposes.

Overview

FDM® Nylon 12 filament is the 3D printing equivalent of standard industrial PA12 (polyamide 12) material. A strong engineering thermoplastic, it exhibits toughness and high impact strength, without being brittle. Its excellent fatigue properties make it a good option for repetitive-flex applications such as snap-fit clips and closures and press-fit inserts.

Other applications include jigs, fixtures and low-volume production parts, as well as accurate prototyping of nylon 12 high-volume injection molded parts. FDM Nylon 12 is available in black.

Contents:

Ordering Information 3
Physical Properties 4
Mechanical Properties 5
Appendix 7

Ordering Information

Table 1. Printer and Support Material Compatibility

Printer	Model Tip (Slice)	Support Material	Support Tip
Fortus 450mc™	T12 (7 slice) T16 (10 slice) T20 (13 slice)	SR-110 (soluble)	T12SR100
Fortus 900mc™/F900™	T12 (7 slice) T16 (10 slice) T20 (13 slice)	SR-110 (soluble)	T12SR100

Build Sheet

Nylon

- 0.02 x 26 x 38 in. (0.51 x 660 x 965 mm)
- 0.02 x 16 x 18.5 in. (0.51 x 406 x 470 mm)

Table 2. FDM Nylon 12 Ordering Information

Part Number	Description
Filament Canisters [1] [2]	
355-02230	Nylon 12, 92.3 cu in. - Plus
310-21800	Nylon 12, 92.3 cu in. - Classic
355-03130	SR-110 soluble support, 92.3 cu in. - Plus
310-32200	SR-110 soluble support, 92.3 cu in. - Classic
Printer Consumables	
511-10301	T12 tip
511-10401	T16 tip
511-10701	T20 tip
511-10100	T12SR-100 tip
355-00750-S	Nylon build sheet, 0.02x16x18.5 in. (0.51x406x470 mm)
310-00450-S	Nylon build sheet, 0.03x16x18.5 in. (0.76x406x470 mm)
325-00650-S	Nylon build sheet, 0.02x26x38 in. (0.51x660x965 mm)
325-00750-S	Nylon build sheet, 0.02x14x16.5 in. (0.51x356x420mm)

[1] Classic canisters are compatible with all Fortus 900mc™ printers prior to s/n L502.

[2] Plus canisters are compatible with all Fortus 450mc™, all Stratasys F900™, and Fortus 900mc™ printers s/n L502 and up.

Physical Properties

Values are measured as printed. XY, XZ, and ZX orientations were tested. For full details refer to the Stratasys Materials Test Report (immediate download upon clicking the link). DSC and TMA curves can be found in the Appendix.

Table 3. FDM Nylon 12 Physical Properties

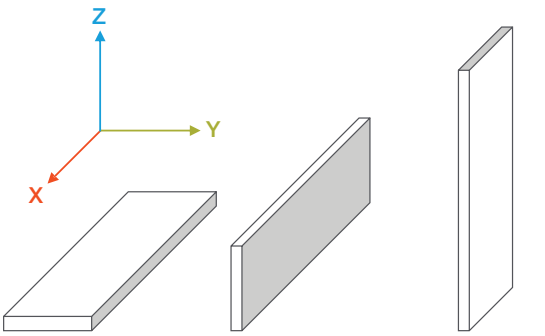
Property	Test Method	Typical Values	
		XY	XZ/ZX
HDT @ 66 psi	ASTM D648 Method B	94.7 C (202.5 F)	91.9 C (197.5 F)
HDT @ 264 psi	ASTM D648 Method B	84.3 C (183.8 F)	75.3 C (167.5 F)
Tg	ASTM D7426 Inflection Point	34.03 C (92.25 F)	
Mean CTE	ASTM E831 (-50 °C to 10 °C)	84.35 µm/[m*°C] 46.86 µin/[in*°F]	85.56 µm/[m*°C] 47.53 µin/[in*°F]
Mean CTE	ASTM E831 (10 °C to 45 °C)	89.12 µm/[m*°C] 49.51 µin/[in*°F]	-
Mean CTE	ASTM E831 (45 °C to 70 °C)	98.23 µm/[m*°C] 55.83 µin/[in*°F]	-
Mean CTE	ASTM E831 (70 °C to 95 °C)	60.08 µm/[m*°C] (33.38 µin/[in*°F])	-
Mean CTE	ASTM E831 (10C to 50C)	-	97.08 µm/[m*°C] 53.93 µin/[in*°F]
Mean CTE	ASTM E831 (50C to 70C)	-	102.8 µm/[m*°C] 57.11 µin/[in*°F]
Volume Resistivity	ASTM D257	> 6.87*10^13 Ω*cm	
Dielectric Constant	ASTM D150 1 kHz test condition	3.11	2.78
Dielectric Constant	ASTM D150 2 MHz test condition	2.48	2.52
Dissipation Factor	ASTM D150 1 kHz test condition	0.066	0.009
Dissipation Factor	ASTM D150 2 MHz test condition	0.014	0.008
Specific Gravity	ASTM D257 @23 °C	1.01	

Mechanical Properties

Nylon 12 samples were printed with a 0.010 in. (0.254 mm) layer height on the F900. For the full test procedure please see the Stratasys Materials Test Procedure (immediate download upon clicking the link).

Print Orientation

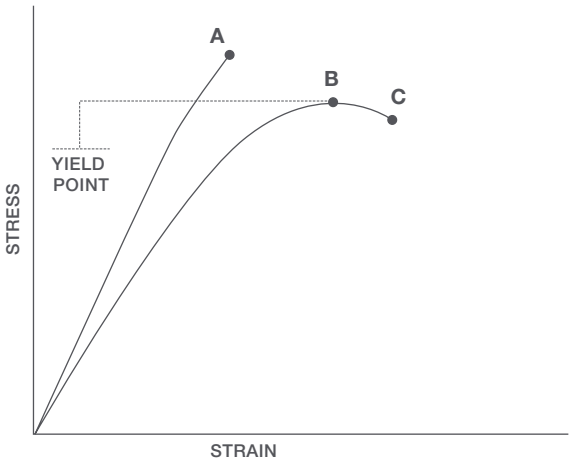
Parts created using FDM are anisotropic as a result of the printing process. Below is a reference of the different orientations used to characterize the material.



Flat (XY) On Edge (XZ) Upright (ZX)

Tensile Curves

Due to the anisotropic nature of FDM, tensile curves look different depending on orientation. Below is a guide of the two types of curves seen when printing tensile samples and what reported values mean.



A = Tensile at break, elongation at break (no yield point)
B = Tensile at yield, elongation at yield
C = Tensile at break, elongation at break

Table 4. FDM Nylon 12 Mechanical Properties (F900 - T16 Tip)

		XZ Orientation[1]	ZX Orientation[1]
Tensile Properties: ASTM D638			
Yield Strength	MPa	49.3 (0.48)	41.8 (0.67)
	psi	7140 (70)	6060 (97)
Elongation @ Yield	%	6.1 (0.068)	5.8 (0.16)
Strength @ Break	MPa	33.4 (1.7)	41.2 (0.72)
	psi	4840 (240)	5890 (100)
Elongation @ Break	%	30 (23)	6.5 (0.39)
Modulus (Elastic)	GPa	1.51 (0.087)	1.25 (0.12)
	ksi	218 (13)	181 (18)
Flexural Properties: ASTM D790, Procedure A			
Strength @ Break	MPa	No break	No break
	psi	No break	No break
Strength @ 5% Strain	MPa	56.5 (5.0)	54.5 (4.7)
	psi	8190 (720)	7900 (690)
Strain @ Break	%	No break	No break
Modulus	GPa	1.26 (0.13)	1.20 (0.12)
	ksi	182 (18)	174 (17)
Compression Properties: ASTM D695			
Yield Strength	MPa	327 (33)	557 (48)
	psi	47400 (4700)	80700 (7000)
Modulus	GPa	1.48 (0.069)	1.65 (0.091)
	ksi	215 (9.9)	240 (13)
Impact Properties: ASTM D256, ASTM D4812			
Notched	J/m	138 (22)	71.0 (14)
	ft*lb/in.	2.58 (0.41)	1.33 (0.27)
Unnotched	J/m	1800 (240)	322 (130)
	ft*lb/in.	33.8 (4.6)	6.03 (2.4)

[1] Values in parenthesis are standard deviations.

Appendix

Figure 1. 2nd heating scan DSC data for the Nylon 12 Flat (XY) sample.

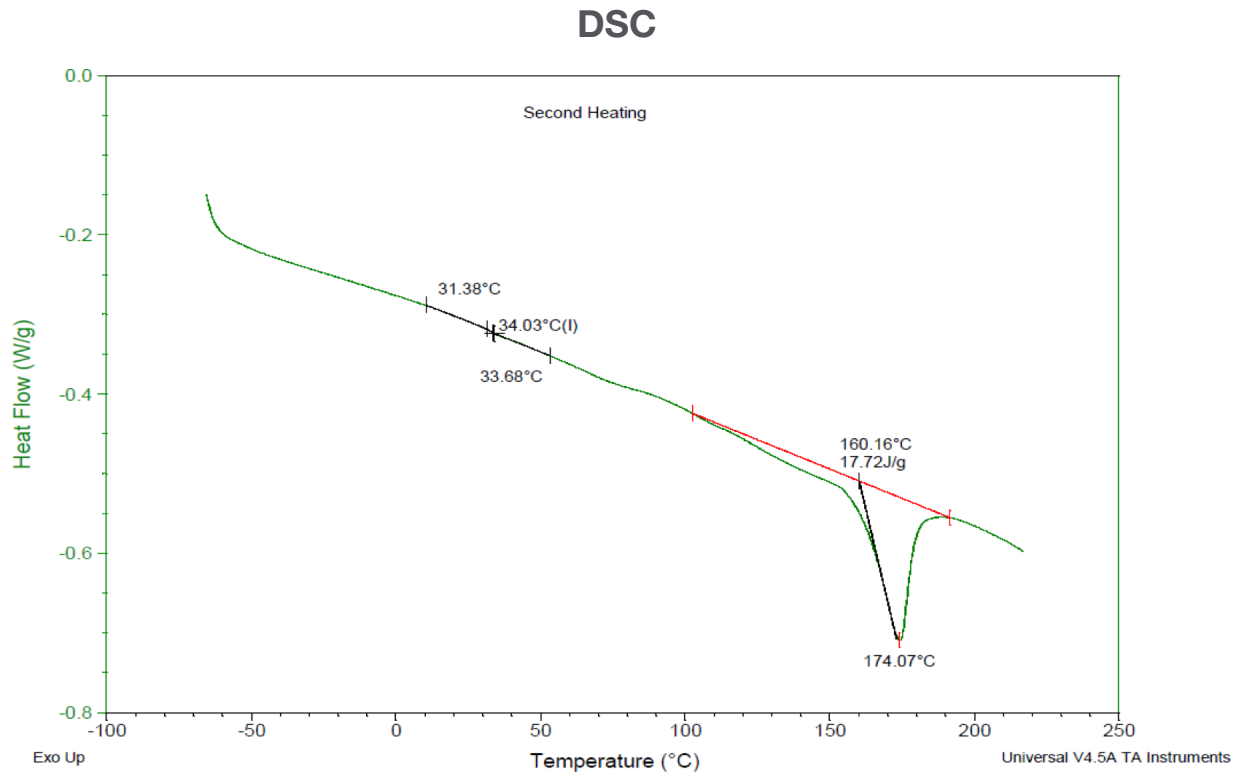


Figure 2. Dimension change data as a function of temperature for the Nylon 12 Flat (XY) sample.

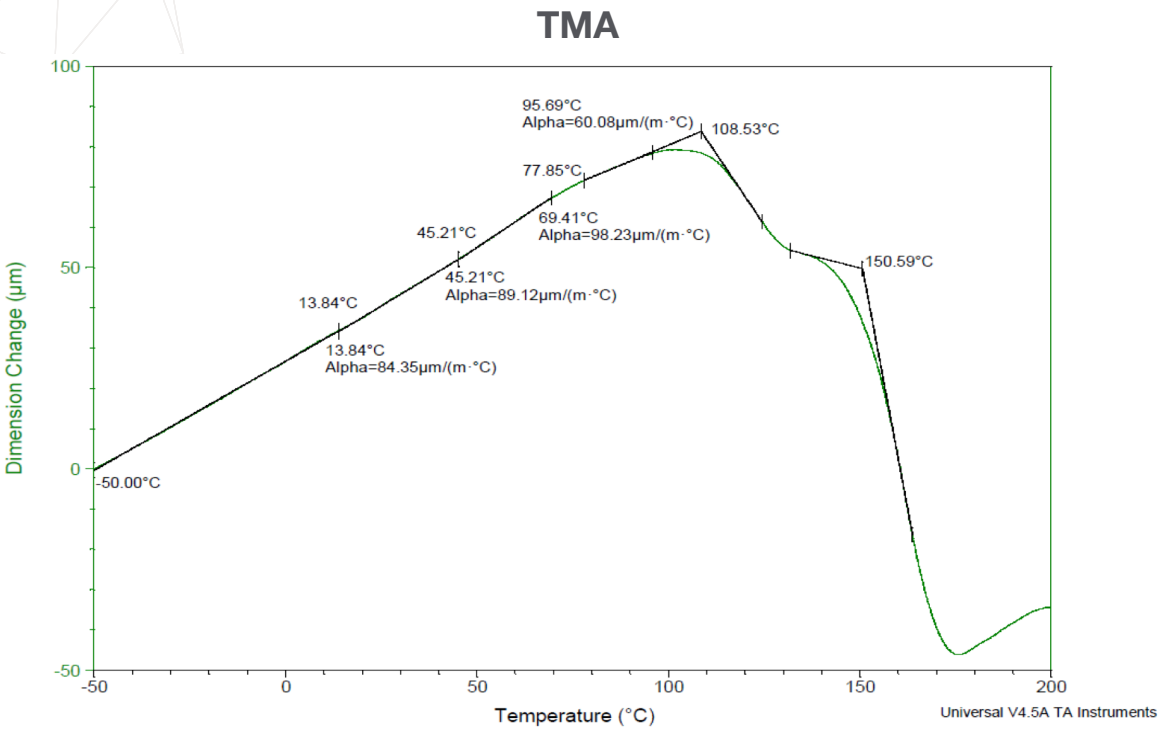


Figure 3. Dimension change data as a function of temperature for the Nylon 12 On Edge (XZ) sample.

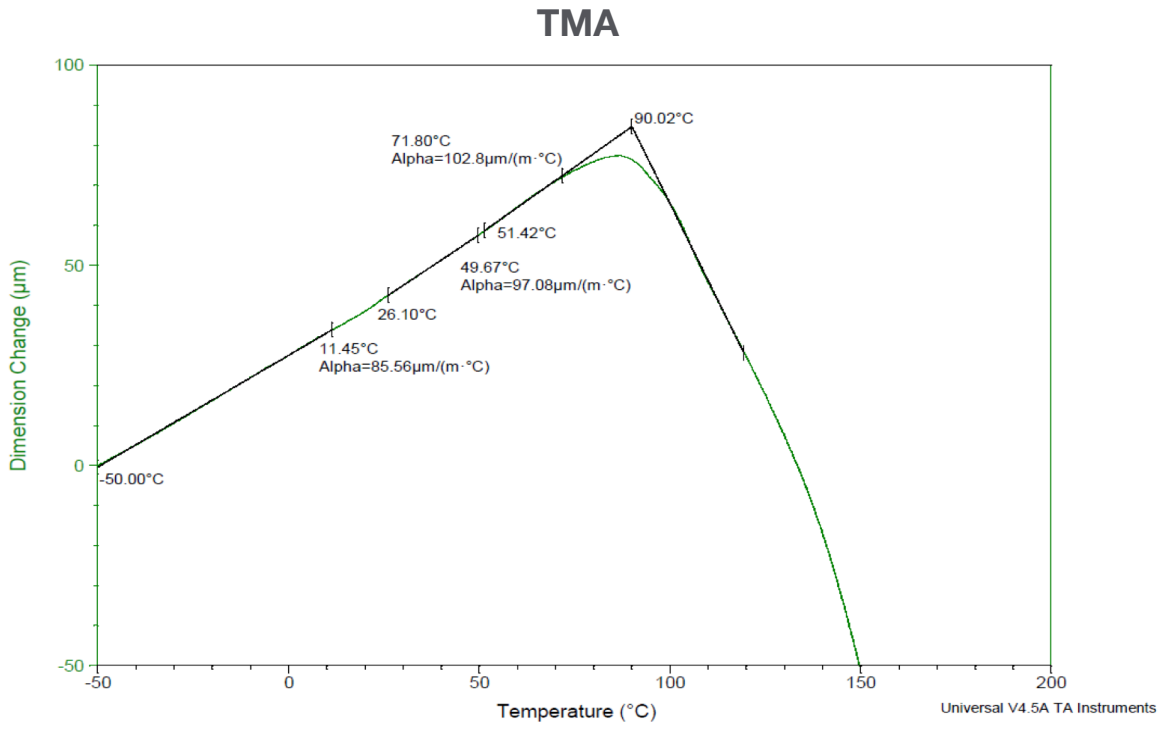
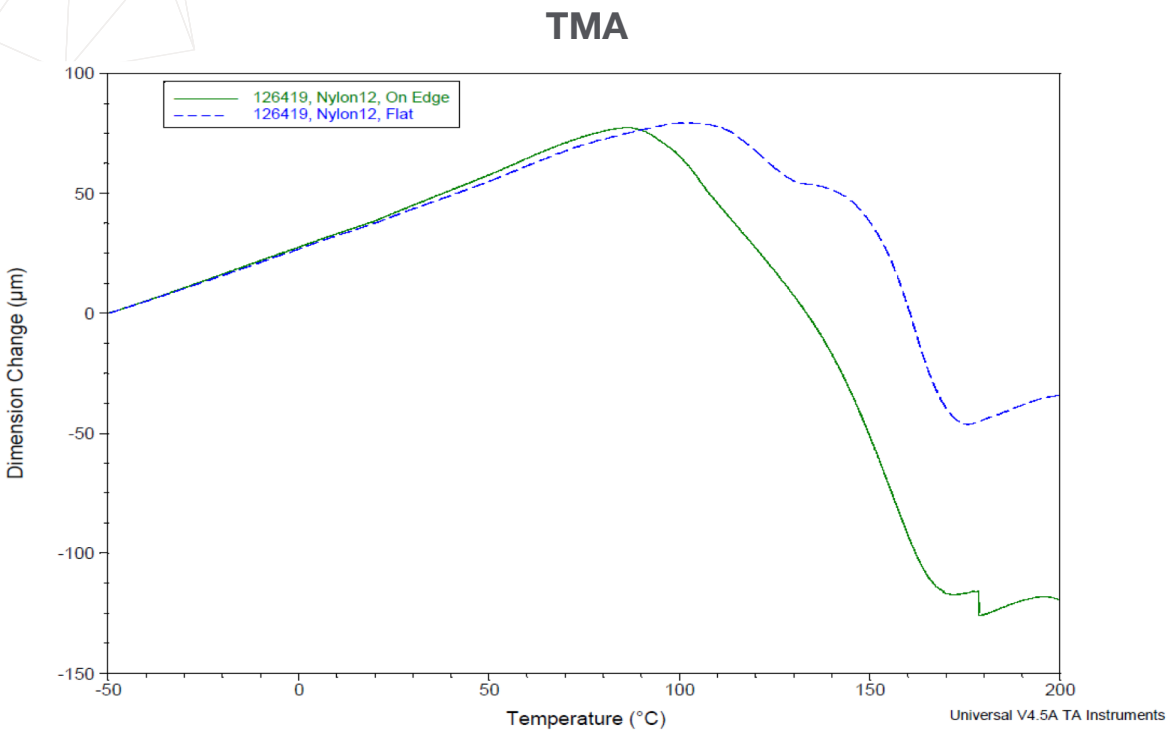


Figure 4. Overlay of the dimension change data for the Flat (XY) and On Edge (XZ) Nylon 12 samples.



Stratasys Headquarters

7665 Commerce Way,
Eden Prairie, MN 55344
+1 800 801 6491 (US Toll Free)
+1 952 937-3000 (Intl)
+1 952 937-0070 (Fax)

1 Holtzman St., Science Park,
PO Box 2496
Rehovot 76124, Israel
+972 74 745 4000
+972 74 745 5000 (Fax)

stratasys.com
ISO 9001:2015 Certified

FDM Nylon 12CF

FDM Thermoplastic Filament

The information presented are typical values intended for reference and comparison purposes only.
They should not be used for design specifications or quality control purposes.

Overview

FDM® Nylon 12CF™ is a PA12 (polyamide 12) thermoplastic filament reinforced with chopped carbon fiber, 35% by weight. It has the highest flexural strength of any FDM thermoplastic, resulting in the highest stiffness-to-weight ratio. The combination of high strength, stiffness and light weight makes it an optimal replacement for heavier metal components in appropriate use cases.

Typical applications include strong, lightweight tooling, functional prototyping and select end-use parts.

Contents:

Ordering Information 3
Physical Properties 4
Mechanical Properties 5
Appendix 7

Ordering Information

Table 1. Printer and Support Material Compatibility

Printer	Model Tip (Slice)	Support Material	Support Tip
Fortus 450mc™	T20C (10 slice)	SR-110™ (soluble)	T12SR100
F900™	T20C (10 slice)	SR-110 (soluble)	T12SR100

Build Sheet

Nylon

- 0.02 x 26 x 38 in. (0.51 x 660 x 965 mm)
- 0.02 x 16 x 18.5 in. (0.51 x 406 x 470 mm)

Hardware

Due to the high abrasion of this material, a system upgrade is required to support a hardened head and drive wheels. Ordering information can be found in Table 2.

Table 2. FDM Nylon 12CF Ordering Information

Part Number	Description
Filament Canisters	
355-02411	FDM Nylon 12CF, 92.3 cu in. - Plus
355-03130	SR-110 Soluble Support, 92.3 cu in. - Plus
Printer Consumables	
511-10720	T20C tip
511-10100	T12SR100 tip
325-00600-S	Nylon build sheet, 0.02x26x38 in. (0.51x660x965 mm)
325-00700-S	Nylon build sheet, 0.02x16x18.5 in. (0.51x406x470 mm)
System Upgrades	
335-60000	Fortus 900mc Gen 3 Upgrade from Gen 1 & 2 Systems
325-63500	Hardened F900 Head Only

Physical Properties

Values are measured as printed. XY, XZ, and ZX orientations were tested. For full details refer to the Stratasys Materials Test Report (immediate download upon clicking the link). DSC and TMA curves can be found in the Appendix.

Table 3. FDM Nylon 12CF Physical Properties

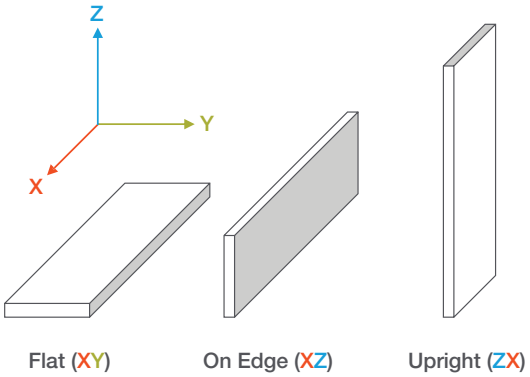
Property	Test Method	Typical Values	
		XY	XZ/ZX
HDT @ 66 psi	ASTM D648 Method B	160.4 C (320.7 F)	168.1 C (334.6 F)
HDT @ 264 psi	ASTM D648 Method B	129.8 C (265.7 F)	153.7 C (308.7 F)
Tg	ASTM D7426 Inflection Point	37.53 C (99.55 F)	
Mean CTE	ASTM E831 (-50 °C to 20 °C)	115.7 µm/[m*°C] (67.28 µin/[in*°F])	37.31 µm/[m*°C] (20.73 µin/[in*°F])
Mean CTE	ASTM E831 (20 °C to 60 °C)	180.5 µm/[m*°C] (100.3 µin/[in*°F])	
Mean CTE	ASTM E831 (60 °C to 115 °C)	195.8 µm/[m*°C] (108.8 µin/[in*°F])	
Mean CTE	ASTM E831 (115 °C to 150 °C)	296.5 µm/[m*°C] (164.7 µin/[in*°F])	
Mean CTE	ASTM E831 (20 °C to 105 °C)		46.15 µm/[m*°C] (25.64 µin/[in*°F])
Mean CTE	ASTM E831 (105 °Cto 150 °C)		58.43 µm/[m*°C] (32.46 µin/[in*°F])
Volume Resistivity	ASTM D257	2.84*10^7 Ω*cm	
Dielectric Constant	ASTM D150 1 kHz test condition	Too conductive	
Dielectric Constant	ASTM D150 2 MHz test condition	11.4	10.0
Dissipation Factor	ASTM D150 1 kHz test condition	Too conductive	
Dissipation Factor	ASTM D150 2 MHz test condition	0.100	0.000
Thermal Conductivity	ASTM E1952 @0C	0.5884 W/m*K 0.3400 BTU/(hr*ft*F)	
Thermal Conductivity	ASTM E1952 @30C	0.5988 W/m*K 0.3460 BTU/(hr*ft*F)	
Thermal Conductivity	ASTM E1952 @60C	0.5800 W/m*K 0.3352 BTU/(hr*ft*F)	
Thermal Conductivity	ASTM E1952 @90C	0.6153 W/m*K 0.3556 BTU/(hr*ft*F)	
Thermal Diffusivity	ASTM E1952 @0C	0.363 mm^2/s 5.63*10^-4 in^2/s	
Thermal Diffusivity	ASTM E1952 @30C	0.324 mm^2/s 5.02*10^-4 in^2/s	
Thermal Diffusivity	ASTM E1952 @60C	0.266 mm^2/s 4.12*10^-4 in^2/s	
Thermal Diffusivity	ASTM E1952 @90C	0.255 mm^2/s 3.95*10^-4 in^2/s	
Specific Gravity	ASTM D257 @23 °C	1.190	

Mechanical Properties

FDM Nylon 12CF samples were printed with a 0.010 in. (0.254 mm) layer height on the F900. For the full test procedure please see the Stratasys Materials Test Procedure (immediate download upon clicking the link).

Print Orientation

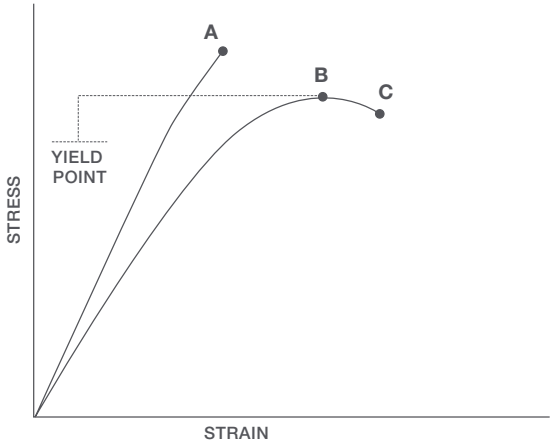
Parts created using FDM are anisotropic as a result of the printing process. Below is a reference of the different orientations used to characterize the material.



Flat (XY) On Edge (XZ) Upright (ZX)

Tensile Curves

Due to the anisotropic nature of FDM, tensile curves look different depending on orientation. Below is a guide of the two types of curves seen when printing tensile samples and what reported values mean.



A = Tensile at break, elongation at break (no yield point)
B = Tensile at yield, elongation at yield
C = Tensile at break, elongation at break

Table 4. FDM Nylon 12CF Mechanical Properties (F900 - T20C tip)

		XZ Orientation[1]	ZX Orientation[1]
Tensile Properties: ASTM D638			
Yield Strength	MPa	No yield	No yield
	psi	No yield	No yield
Elongation @ Yield	%	No yield	No yield
Strength @ Break	MPa	83.5 (1.7)	32.7 (3.5)
	psi	12100 (250)	4750 (510)
Elongation @ Break	%	2.4 (0.29)	1.2 (0.27)
Modulus (Elastic)	GPa	9.46 (0.46)	3.00 (0.43)
	ksi	1370 (67)	434 (63)
Flexural Properties: ASTM D790, Procedure A			
Strength @ Break	MPa	153 (2.1)	62.4 (3.4)
	psi	22200 (310)	9080 (490)
Strain @ Break	%	2.65 (0.086)	3.10 (0.26)
Modulus	GPa	11.1 (0.28)	2.34 (0.085)
	ksi	1610 (40)	339 (12)
Compression Properties: ASTM D695			
Yield Strength	MPa	110 (3.0)	141 (2.6)
	psi	16000 (440)	20400 (380)
Modulus	GPa	6.78 (0.55)	3.67 (0.11)
	ksi	984 (79)	532 (16)
Impact Properties: ASTM D256, ASTM D4812			
Notched	J/m	106 (6.6)	24 (3.2)
	ft*lb/in.	1.99 (0.12)	0.45 (0.060)
Unnotched	J/m	346 (40)	121 (18)
	ft*lb/in.	6.48 (0.74)	2.27 (0.33)

[1] Values in parenthesis are standard deviations.

Appendix

Figure 1. 2nd heating scan DSC data for the Nylon 12CF Flat (XY) sample.

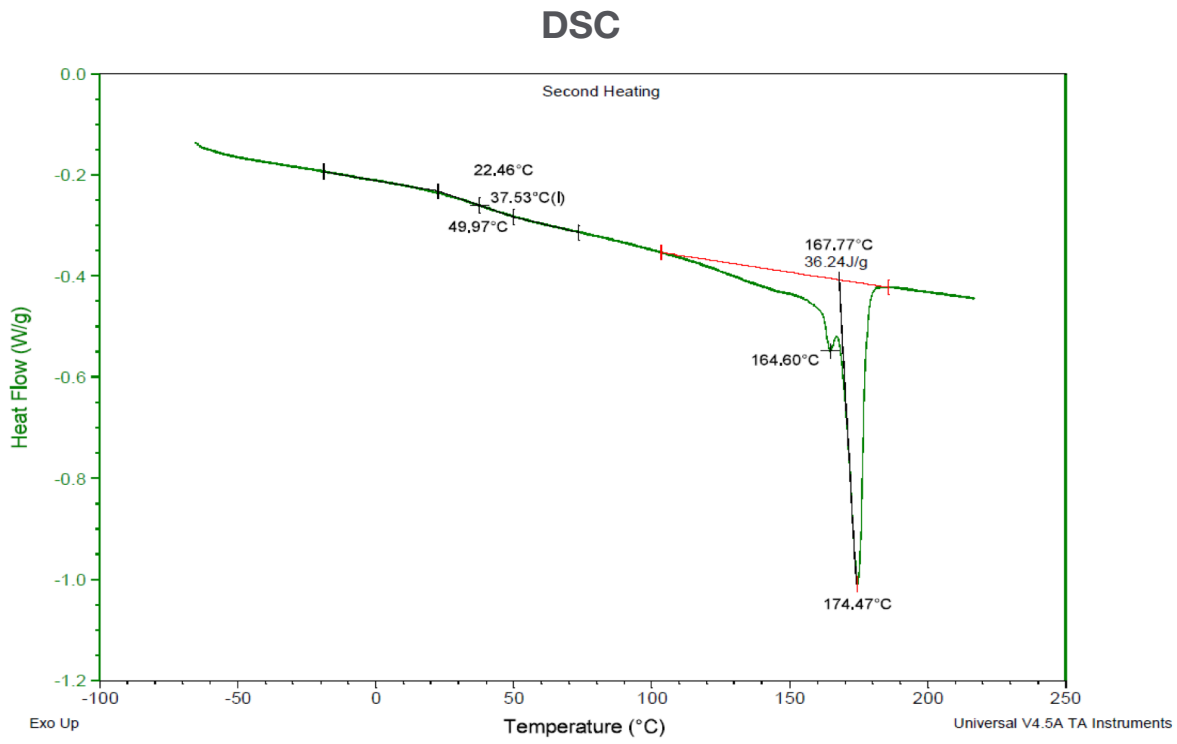


Figure 2. Dimension change data as a function of temperature for the Nylon 12CF Flat (XY) sample.

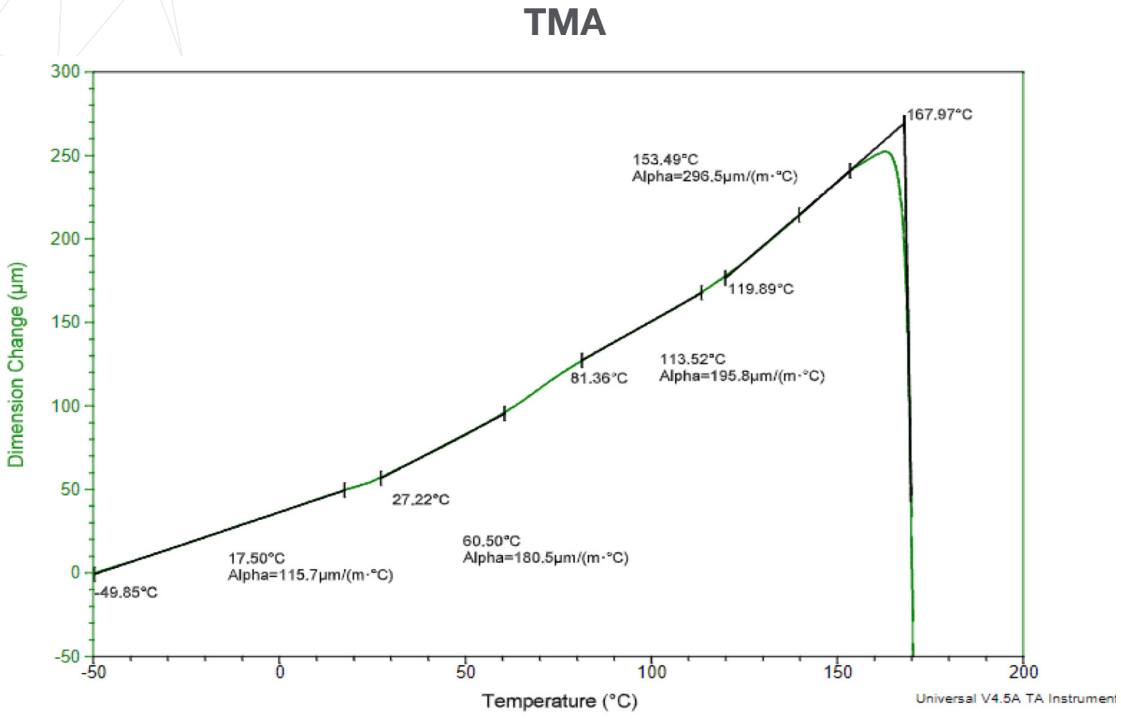


Figure 3. Dimension change data as a function of temperature for the Nylon 12CF On Edge (XZ) sample.

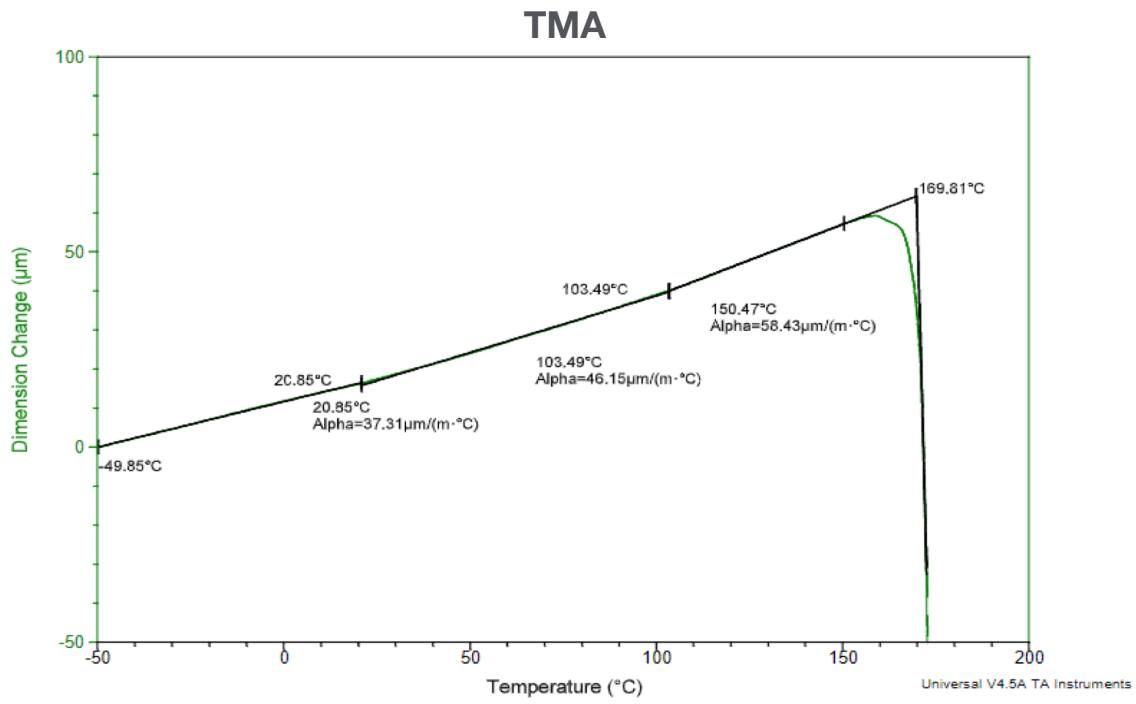
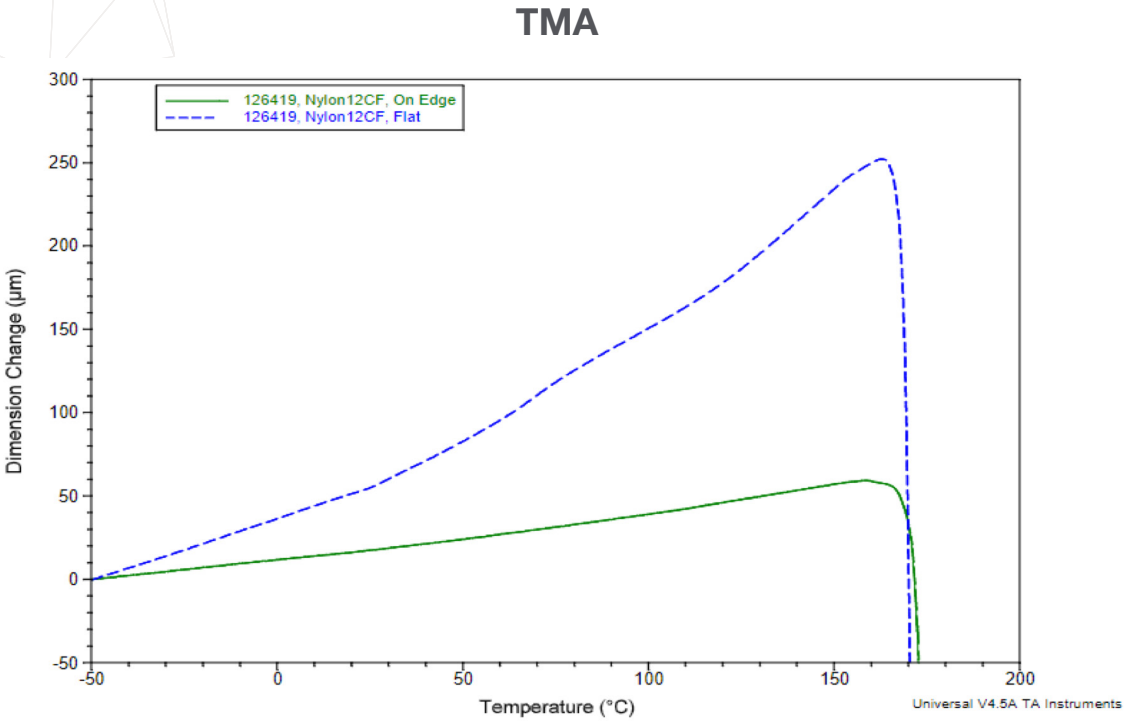


Figure 4. Overlay of the dimension change data for the Flat (XY) and On Edge (XZ) Nylon 12CF samples.



USA - Headquarters
7665 Commerce Way
Eden Prairie, MN 55344, USA
+1 952 937 3000

EMEA
Airport Boulevard B 120
77836 Rheinmünster, Germany
+49 7229 7772 0

ISRAEL - Headquarters
1 Holtzman St., Science Park
PO Box 2496
Rehovot 76124, Israel
+972 74 745 4000

ASIA PACIFIC
7th Floor, C-BONS International Center
108 Wai Yip Street Kwun Tong Kowloon
Hong Kong, China
+ 852 3944 8888

GET IN TOUCH.
www.stratasys.com/contact-us/locations

stratasys.com
ISO 9001:2015 Certified

Antero 800NA

FDM Thermoplastic Filament

The information presented are typical values intended for reference and comparison purposes only.
They should not be used for design specifications or quality control purposes.

Overview

Antero™ 800NA is a PEKK-based FDM® thermoplastic with excellent mechanical properties that include high strength, high heat resistance, toughness and wear-resistance. These superior qualities make it a lighter alternative to aluminum and steel in certain use cases.

Chemical resistance and minimal outgassing provide suitability for aerospace applications where prototypes and parts are exposed to jet fuel, oil and hydraulic fluid. Other uses include industrial applications where high-strength and chemical resistance are needed.

3D printing with Antero 800NA FDM filament avoids the waste associated with subtractive manufacturing of high-cost bulk PEKK material.

Contents:

Ordering Information 3
Physical Properties 4
Mechanical Properties 5
Flame, Smoke, and Toxicity Test Results 9
Outgassing 10
Appendix 12

Ordering Information

Table 1. Printer and Support Material Compatibility

Printer	Model Tip (Slice)	Support Material	Support Tip
Fortus 450mc™	T20F (10 slice)	SUP8000B™ (breakaway)	T16
F900™	T20F (10 slice)	SUP8000B (breakaway)	T16

Build Sheet

High Temperature

- 0.02 x 26 x 38 in. (0.51 x 660 x 965 mm)
- 0.02 x 16 x 18.5 in. (0.51 x 406 x 470 mm)

Hardware

Hardened Upgrade

Table 2. Antero 800NA Ordering Information

Part Number	Description
Filament Canisters	
355-02500	Antero 800NA, 92.3 cu. in. – Plus
355-03260	SUP8000B, 92.3 cu. in. – Plus
Printer Consumables	
511-10730-S	T20D tip
511-10740-S	T20F tip
511-10401	T16 tip
325-00275-S	High Temperature build sheet, 0.02x26x38 in. (0.51x660x965 mm)
325-00475-S	High Temperature build sheet, 0.02x16x18.5 in. (0.51x406x470 mm)

Physical Properties

Values are measured as printed. XY, XZ, and ZX orientations were tested. For full details refer to the Stratasys Materials Test Report (immediate download upon clicking the link). DSC and TMA curves can be found in the Appendix.

Table 3. Antero 800NA Physical Properties

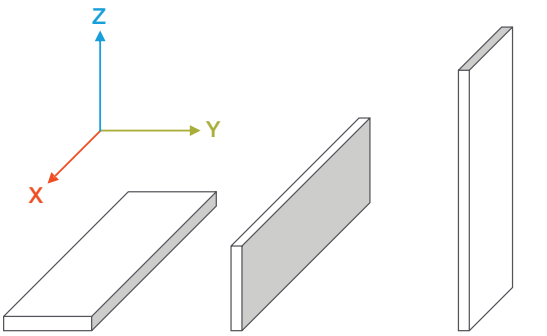
Property	Test Method	Units	Typical Values	
			XY	XZ/ZX
HDT @ 66 psi	ASTM D648 Method B		150.71 C (303.28 F)	
HDT @ 264 psi	ASTM D648 Method B		147.23 C (297.01 F)	
Tg	ASTM D7426 Inflection Point		155.81 C (312.46 F)	
Melt Point	ASTM D7426 Peak Heat		300.23 C (572.41 F)	
Mean CTE	ASTM E831 (40 °C to 140 °C)		36.11 µm/[m*°C] (20.06 µin/[in*°F])	50.20 µm/[m*°C] (27.89 µin/[in*°F])
Volume Resistivity	ASTM D257		> 1.4*10^14 Ω*cm	
Dielectric Constant	ASTM D150 1 kHz test condition		3.32	
Dissipation Factor	ASTM D150 1 kHz test condition		0.003	
Thermal Conductivity	ASTM E1952 @0C	W/m*K BTU/(hr*ft*F)	0.2988 0.1727	
Thermal Conductivity	ASTM E1952 @30C	W/m*K BTU/(hr*ft*F)	0.3011 0.1740	
Thermal Conductivity	ASTM E1952 @60C	W/m*K BTU/(hr*ft*F)	0.3054 0.1765	
Thermal Conductivity	ASTM E1952 @90C	W/m*K BTU/(hr*ft*F)	0.3088 0.1785	
Thermal Diffusivity	ASTM E1952 @0C	mm^2/s in^2/s	0.193 2.99*10^-4	
Thermal Diffusivity	ASTM E1952 @30C	mm^2/s in^2/s	0.174 2.70*10^-4	
Thermal Diffusivity	ASTM E1952 @60C	mm^2/s in^2/s	0.162 2.51*10^-4	
Thermal Diffusivity	ASTM E1952 @90C	mm^2/s in^2/s	0.152 2.36*10^-4	
Specific Gravity	ASTM D257 @23 °C		1.28	

Mechanical Properties

Samples were printed with 0.010 in. (0.254 mm) layer heights on the Fortus 450mc and F900 with T20F tip. For the full test procedure please see Stratasys Materials Test Procedure (immediate download upon clicking the link).

Print Orientation

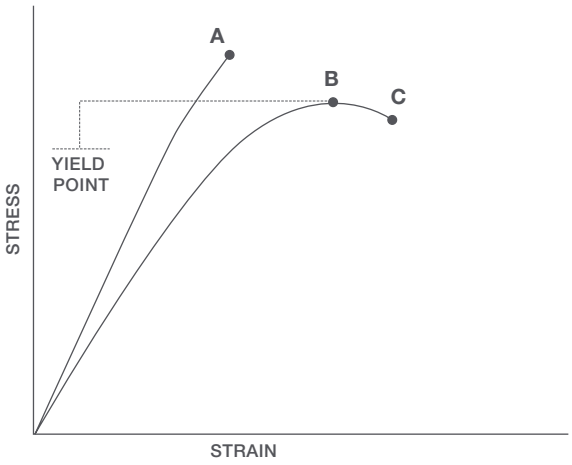
Parts created using FDM are anisotropic as a result of the printing process. Below is a reference of the different orientations used to characterize the material.



Flat (XY) On Edge (XZ) Upright (ZX)

Tensile Curves

Due to the anisotropic nature of FDM, tensile curves look different depending on orientation. Below is a guide of the two types of curves seen when printing tensile samples and what reported values mean.



A = Tensile at break, elongation at break (no yield point)
B = Tensile at yield, elongation at yield
C = Tensile at break, elongation at break

Table 4. Antero 800NA Mechanical Properties - F900 w/T20F Tip

		XZ Orientation[1]	ZX Orientation[1]
Tensile Properties: ASTM D638			
Yield Strength	MPa	86.7 (5.0)	59.4 (5.8)
	psi	12300 (720)	8610 (850)
Elongation @ Yield	%	4.7	2.3
Strength @ Break	MPa	73.0 (4.7)	59.7 (5.5)
	psi	10600 (680)	8650 (800)
Elongation @ Break	%	6.1	2.3
Modulus (Elastic)	GPa	2.64 (0.05)	2.77 (0.04)
	ksi	383 (6500)	402 (5.8)
Flexural Properties: ASTM D790, Procedure A			
Strength @ Break	MPa	No break	106 (13)
	psi	No break	15400 (1900)
Strength @ 5% Strain	MPa	136 (2.3)	
	psi	19800 (340)	
Strain @ Break	%	No break	4.1%
Modulus	GPa	3.20 (0.04) GPa	2.65 (0.03)
	ksi	463 (6.4) ksi	385 (40)
Compression Properties: ASTM D695			
Yield Strength	MPa	95.8 (5.9)	95.4 (4.0)
	psi	13900 (0.85)	13800 (0.58)
Modulus	GPa	2.26 (0.25)	2.30 (0.18)
	ksi	327 (36)	333 (25)
Impact Properties: ASTM D256, ASTM D4812			
Notched	J/m	41.1 (6.9)	33.3 (4.2)
	ft*lb/in.	0.770 (0.13)	0.623 (0.08)
Unnotched	J/m	1730 (680)	203 (35)
	ft*lb/in.	32.5 (13)	3.80 (0.65)

(1) Values in parentheses are standard deviations.

Table 5. Antero 800NA Mechanical Properties - Fortus 450mc w/T20F tip

		XZ Orientation[1]	ZX Orientation[1]
Tensile Properties: ASTM D638			
Yield Strength	MPa	90.0 (5.2)	50.1 (3.6)
	psi	13000 (760)	7270 (530)
Elongation @ Yield	%	4.8	1.8
Strength @ Break	MPa	73.0 (13)	49.4 (3.8)
	psi	10600 (1900)	7170 (550)
Elongation @ Break	%	6.4	1.8
Modulus (Elastic)	GPa	2.71 (0.05)	2.89 (0.05)
	ksi	393 (7.4)	419 (7.8)
Flexural Properties: ASTM D790, Procedure A			
Strength @ Break	MPa	No break	96.6 (11)
	psi	No break	14000 (1700)
Strength @ 5% Strain	MPa	137 (1.85)	
	psi	19900 (260)	
Strain @ Break	%	No break	3.6
Modulus	GPa	3.20 (0.02)	3.84 (0.07)
	ksi	464 (5.8)	411 (11)
Compression Properties: ASTM D695			
Yield Strength	MPa	98.4 (4.8)	102 (1.4)
	psi	14300 (700)	14800 (210)
Modulus	GPa	2.46 (0.03)	2.34 (0.15)
	ksi	357 (4.5)	340 (21)
Impact Properties: ASTM D256, ASTM D4812			
Notched	J/m	40.0 (6.3)	30.1 (6.0)
	ft*lb/in.	0.749 (0.12)	0.564 (0.11)
Unnotched	J/m	2730 (1400)	119 (44)
	ft*lb/in.	51.2 (26)	2.23 (0.82)

(1) Values in parentheses are standard deviations.

Chemical Resistance

Antero 800NA was tested for resistance to chemical exposure per ASTM D543. Chemicals tested and percent change from control is listed below. For further details read the Antero 800NA Chemical Resistance White Paper.

Table 6. Antero 800NA Chemical Resistance Results

Change in Tensile Properties – 168 hour Chemical Exposure (ASTM D543)					
	Reagent	Non-Annealed XZ	Non-Annealed ZX	Annealed XZ	Annealed ZX
Tensile Strength	Dichloromethane	-88%	-81%	-15%	1%
	Ethyl Acetate	-20%	-4%	-19%	-7%
	Jet A	-14%	-3%	11%	-1%
	Methyl Ethyl Ketone	-17%	-7%	-16%	-7%
	Skydrol	-5%	16%	19%	-9%
	Toluene	-17%	-11%	-14%	-9%
	30% Nitric Acid	-8%	6%	-7%	7%
	30% Sulfuric Acid	2%	0%	-4%	1%
	60% NaOH	2%	-5%	7%	1%
	Concentrated Ammonia	2%	-4%	2%	4%
% Elongation @ Break	Dichloromethane	1135%	2264%	-11%	0%
	Ethyl Acetate	9%	-1%	3%	-5%
	Jet A	25%	-1%	45%	2%
	Methyl Ethyl Ketone	21%	-2%	16%	-2%
	Skydrol	24%	26%	48%	-7%
	Toluene	8%	-7%	12%	-7%
	30% Nitric Acid	-10%	8%	-12%	7%
	30% Sulfuric Acid	4%	-3%	-4%	4%
	60% NaOH	9%	-10%	8%	3%
	Concentrated Ammonia	10%	-9%	12%	11%
Tensile Modulus	Dichloromethane	-92%	-93%	-1%	-1%
	Ethyl Acetate	-3%	-4%	-3%	-1%
	Jet A	-3%	-3%	-4%	-3%
	Methyl Ethyl Ketone	-2%	-6%	-4%	-4%
	Skydrol	-3%	-4%	-1%	-4%
	Toluene	-1%	-4%	-3%	-3%
	30% Nitric Acid	0%	-6%	-2%	2%
	30% Sulfuric Acid	2%	0%	2%	-2%
	60% NaOH	-1%	7%	3%	0%
	Concentrated Ammonia	-1%	10%	0%	-8%

Flame, Smoke, and Toxicity

Antero 800NA was printed with a T20D tip on the Stratasys F900 and tested per 14 CFR 25.853, BSS 7238 and 7238, and AITM 2.0007B and 3.0005. The testing establishes that this material meets requirements for:

- 60s and 12s Vertical Burn
- 15s Horizontal Burn
- Toxic Gas Emission
- Heat Release Rate of Cabin Materials
- Smoke Density

Table 7. Antero 800NA Flame, Smoke, and Toxicity Test Results

	Avg Time to Extinguish (seconds)	Avg Burned Length (inches)	Drip Time to Extinguish (seconds)
12 Second Vertical Ignition per 14 CFR 25.853(a), Appendix F, Part I, Paragraph (a)(1)(ii)			
Antero 800NA - Flat Build XY	<1	1.23	0 (no drips)
Antero 800NA - Vertical - ZX	<1	1.11	0 (no drips)
60 Second Vertical Ignition per 14 CFR 25.853(a), Appendix F, Part I, Paragraph (a)(1)(i)			
Antero 800NA - Flat Build XY	1.1	2.45	0 (no drips)
Antero 800NA - Vertical - ZX	1.1	2.86	0 (no drips)

	Avg Time to Extinguish (seconds)	Avg Burned Length (inches)	Burn Rate (inches/minute)
15 Second Horizontal Ignition per 14 CFR 25.853(a), Appendix F, Part I, Paragraph (a)(1)(iv)(v)			
Antero 800NA - Flat Build XY	0	0	0
Antero 800NA - Vertical - ZX	0	0	0

	Test Mode	Average Ds (maximum) within 4 minutes, (^{4}Dmax)
Smoke Density per BSS 7238, Rev. C		
Antero 800NA - Flat Build XY	Flaming	2
Antero 800NA - Vertical - ZX	Flaming	2
Smoke Density per AITM 2.0007B, Issue 3		
Antero 800NA - Flat Build XY	Flaming	1
Antero 800NA - Vertical - ZX	Flaming	2
Antero 800NA - Flat Build XY	Non-flaming	1
Antero 800NA - Vertical - ZX	Non-flaming	1

	Test Mode	CO ppm	SO2 ppm	NOx ppm	HCN ppm	HCl ppm	HF ppm
Toxic Gas Emission per BSS 7239, Rev. A							
Antero 800NA - Flat Build XY		0	1.3	0.5	1	0.2	64
Antero 800NA - Vertical - ZX		0	1.4	0.5	0	0.2	86
Toxic Gas Emission per AITM 3.0005, Issue 2							
Antero 800NA - Flat Build XY	Flaming	60	0	0.9	0.4	0	0
Antero 800NA - Vertical - ZX	Non-flaming	1	0	0	0	0	0
Antero 800NA - Flat Build XY	Flaming	50	0	1.3	0	0	0
Antero 800NA - Vertical - ZX	Non-flaming	1	0	0	0	0	0

	Peak HRR (kW/m2)	Time to Peak Heat Release (seconds)	2 Minute Total HRR (kW-min/m2)
Heat Release Rate of Cabin Materials per 14 CFR 25.853(d), Appendix F, Part IV			
Antero 800NA - Flat Build XY	48.4	150	15.5
Antero 800NA - Vertical - ZX	49.4	92	38.6

Outgassing

Table 8. Antero 800NA Outgassing

Sample	TML (%)	CVCM (%)	WVR (%)
Antero 800NA, T20D tip	0.347	0.004	0.267

Fire Protection of Railway Vehicles

Antero 800NA resin was printed with a T16A tip on the Stratasys F900, using single contour and +45/-45 solid rasters, which are typical default settings and tested per EN-45545-2.

Table 9. ANTERO800NA Resin Fire Protection of Railway Vehicles Test Results for R1 requirement set

Test	Results	5mm XZ	25mm XZ
ISO 5659-2	Ds(4)	-	16.19
50 kW/m2	VOF4		19.87
ISO 5659-2 + EN 45545-2 Appendix C	ITC 4 minutes	-	0.00
50 kW/m2	ITC 8 minutes		0.034
ISO 5660-1	MAHRE (kW/m2)	-	10.5
ISO 5658-2	CFE (kW/m2)	12.5	-

Appendix

Figure 1. 2nd heating scan, DSC, for Antero 800NA.

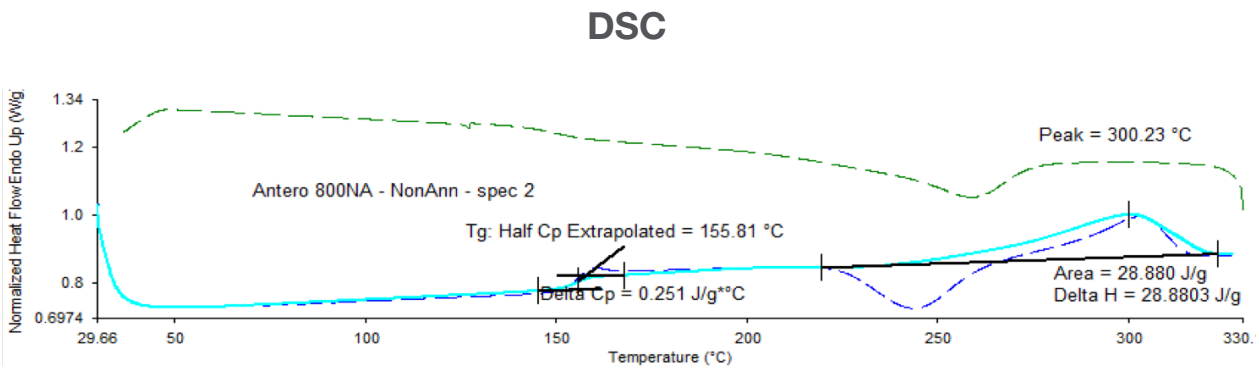


Figure 2. CTE for Antero 800NA through the layers.

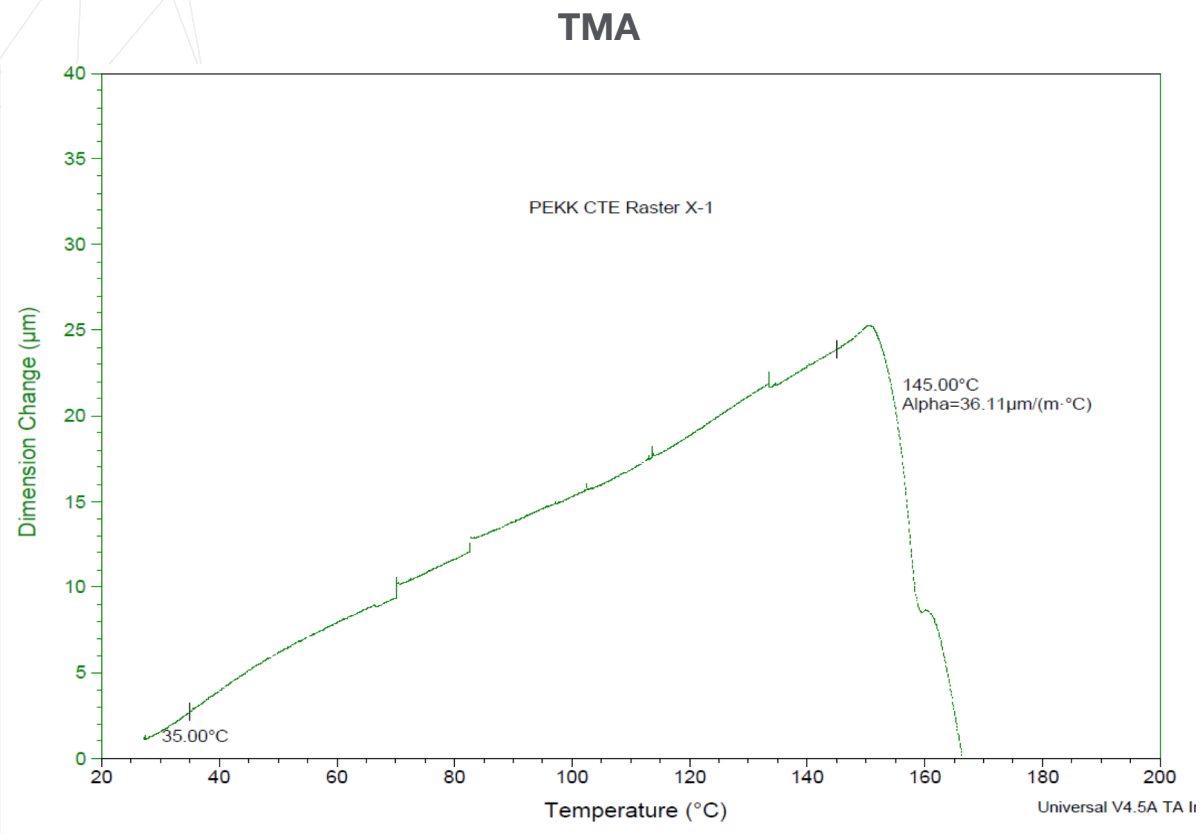
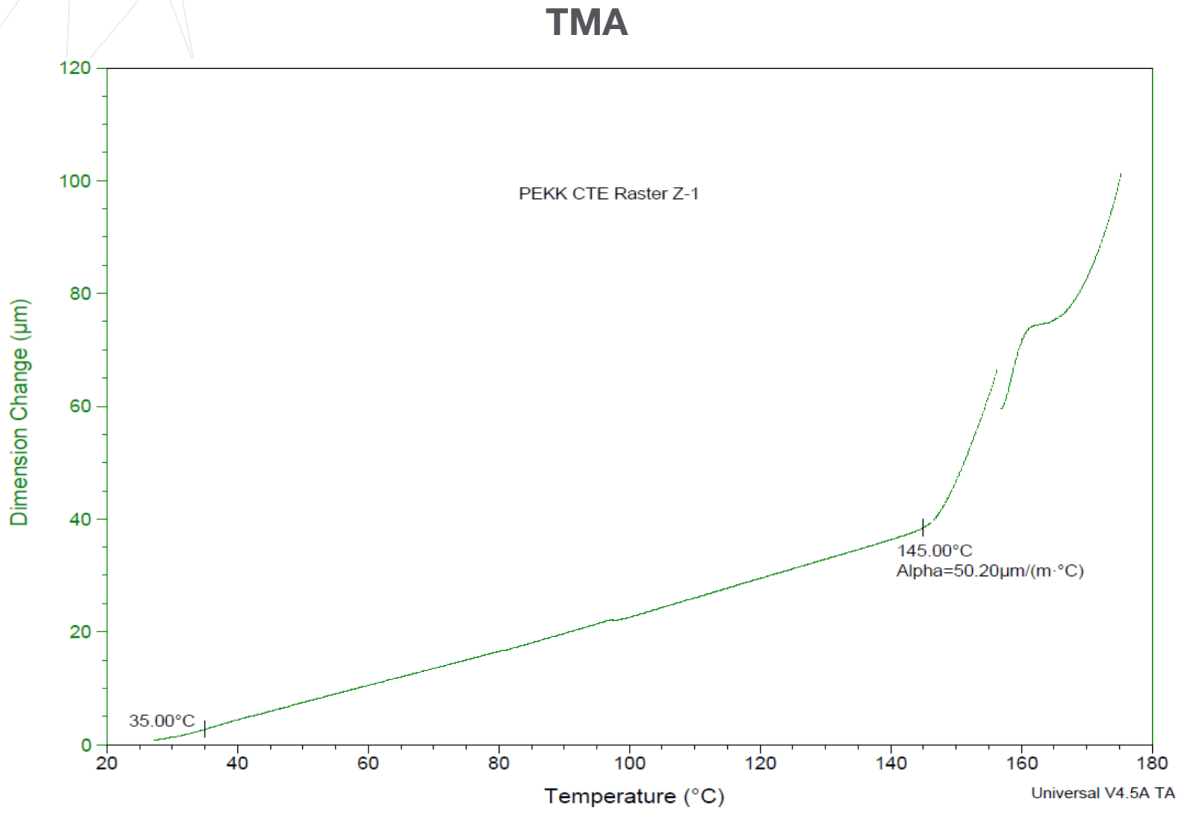


Figure 3. CTE for Antero 800NA in plane to the layers.



Stratasys Headquarters

7665 Commerce Way,
Eden Prairie, MN 55344
+1 800 801 6491 (US Toll Free)
+1 952 937-3000 (Intl)
+1 952 937-0070 (Fax)

1 Holtzman St., Science Park,
PO Box 2496
Rehovot 76124, Israel
+972 74 745 4000
+972 74 745 5000 (Fax)

stratasys.com
ISO 9001:2015 Certified

ABSi

PRODUCTION-GRADE THERMOPLASTIC FOR FORTUS 3D PRINTERS

Fortus® 3D Printers give engineers the ability to manufacture real industrial thermoplastic parts direct from digital files. ABSi™ is an ideal material for conceptual modeling, functional prototyping and direct digital manufacturing. Its strength is superior to standard ABS, and the translucent nature of ABSi is beneficial for monitoring material flow and light transmission, most commonly used for medical and automotive applications. When combined with a Fortus® 3D Printer, ABSi gives you parts that are visually unique, dimensionally accurate, durable and hold their shape over time.

MECHANICAL PROPERTIES[1]	TEST METHOD	ENGLISH	METRIC
Tensile Strength (Type 1, 0.125", 0.2"/min)	ASTM D638	5,400 psi	37 MPa
Tensile Modulus (Type 1, 0.125", 0.2"/min)	ASTM D638	277,700 psi	1,920 MPa
Tensile Elongation (Type 1, 0.125", 0.2"/min)	ASTM D638	4.4%	4.4%
Flexural Strength (Method 1, 0.05"/min)	ASTM D790	8,980 psi	62 MPa
Flexural Modulus (Method 1, 0.05"/min)	ASTM D790	278,000 psi	1,920 MPa
IZOD Impact, notched (Method A, 23°C)	ASTM D256	1.8 ft-lb/in	96.4 J/m
IZOD Impact, un-notched (Method A, 23°C)	ASTM D256	3.6 ft-lb/in	191.1 J/m

THERMAL PROPERTIES[2]	TEST METHOD	ENGLISH	METRIC
Heat Deflection (HDT) @ 66 psi, 0.125" unannealed	ASTM D648	188°F	86°C
Heat Deflection (HDT) @ 264 psi, 0.125" unannealed	ASTM D648	163°F	73°C
Glass Transition Temperature (Tg)	DMA (SSYS)	240°F	116°C
Coefficient of Thermal Expansion	ASTM D696	$6.7x10^{-06}$ in/in/°F	$12.1x10^{-05}$ mm/mm/°C
Melting Point	----------	Not Applicable[3]	Not Applicable[3]

ELECTRICAL PROPERTIES[4]	TEST METHOD	VALUE RANGE
Volume Resistivity	ASTM D257	$1.5x10^{9}$ - $6.1x10^{10}$ ohm-cm
Dielectric Constant	ASTM D150-98	3.4 - 3.6
Dissipation Factor	ASTM D150-98	0.12 - 0.15
Dielectric Strength	ASTM D149-09, Method A	100 - 320 V/mil

STRATASYS.COM

ABSi

PRODUCTION-GRADE THERMOPLASTIC FOR FORTUS 3D PRINTERS

At the core: Advanced FDM Technology

FDM (fused deposition modeling) technology works with engineering-grade thermoplastics to build strong, long-lasting and dimensionally stable parts with the best accuracy and repeatability of any 3D printing technology. These parts are tough enough to be used as advanced conceptual models, functional prototypes, manufacturing tools and production parts.

Meet production demands

FDM systems are as versatile and durable as the parts they produce. Advanced FDM 3D Printers boast the largest build envelopes and material capacities in their class, delivering longer, uninterrupted build times, bigger parts and higher quantities than other additive manufacturing systems, delivering high throughput, duty cycles and utilization rates.

Opening the way for new possibilities

FDM 3D Printers streamline processes from design through manufacturing, reducing costs and eliminating traditional barriers along the way. Industries can cut lead times and costs, products turn out better and get to market faster.

No special facilities needed

FDM 3D Printers are easy to operate and maintain compared to other additive fabrication systems because there are no messy powders or resins to handle and contain, and no special venting is required because FDM systems don't produce noxious fumes, chemicals or waste.

OTHER[2]	TEST METHOD	VALUE
Specific Gravity	ASTM D792	1.08
Rockwell Hardness	ASTM D785	R108

SYSTEM AVAILABILITY	LAYER THICKNESS CAPABILITY	SUPPORT STRUCTURE	AVAILABLE COLORS
Fortus 900mc™	0.013 inch (0.330 mm) 0.010 inch (0.254 mm) 0.007 inch (0.178 mm) 0.005 inch (0.127 mm)	Soluble Supports	Translucent Natural Translucent Amber Translucent Red

The information presented are typical values intended for reference and comparison purposes only. They should not be used for design specifications or quality control purposes. End-use material performance can be impacted (+/-) by, but not limited to, part design, end-use conditions, test conditions, etc. Actual values will vary with build conditions. Tested parts were built on Fortus 400mc™ @ 0.010" (0.254 mm) slice. Product specifications are subject to change without notice.

The performance characteristics of these materials may vary according to application, operating conditions, or end use. Each user is responsible for determining that the Stratasys material is safe, lawful, and technically suitable for the intended application, as well as for identifying the proper disposal (or recycling) method consistent with applicable environmental laws and regulations. Stratasys makes no warranties of any kind, express or implied, including, but not limited to, the warranties of merchantability, fitness for a particular use, or warranty against patent infringement.

[1]Build orientation is on side long edge.

[2]Literature value unless otherwise noted.

[3]Due to amorphous nature, material does not display a melting point.

[4]All Electrical Property values were generated from the average of test plaques built with default part density (solid). Test plaques were 4.0 x 4.0 x 0.1 inches (102 x 102 x 2.5 mm) and were built both in the flat and vertical orientation. The range of values is mostly the result of the difference in properties of test plaques built in the flat vs. vertical orientation.

stratasys

STRATASYS.COM

ISO 9001:2008 Certified

HEADQUARTERS

7665 Commerce Way, Eden Prairie, MN 55344
+1 888 480-3548 (US Toll Free)
+1 952 937-3000 (Intl)
+1 952 937-0070 (Fax)

1 Holtzman St., Science Park, PO Box 2496
Rehovot 76124, Israel
+972 74 745-4000
+972 74 745-5000 (Fax)

MSS_FDM_ABSi_EN_1117a

ST-130

SACRIFICIAL TOOLING MATERIAL

ST-130™ is a model material for sacrificial tooling that simplifies the production of hollow composite parts. Complex tools can be 3D printed and easily dissolved after curing, eliminating secondary processes like mold making and accelerating the development and production of composite structures. Engineered and tested specifically for sacrificial tooling, ST-130 withstands the heat and pressure of autoclave curing. And it 3D prints with a permeable triangle fill pattern designed to optimize build speed, conserve material and dissolve quickly.

ST-130 is available on the Fortus 450mc™ and Fortus 900mc™ 3D Printers. This solution provides increased ease of use, improved part yield and quality – and is ideal for automotive, aerospace and sporting goods industries.

MECHANICAL PROPERTIES	TEST METHOD	ENGLISH	METRIC
Compressive Strength, Peak Load, On Edge	ASTM D695	1,633 lbf	7.3 kN
Compressive Strength, Peak Load, Upright	ASTM D695	3,103 lbf	13.8 kN
Compressive Strength, Peak Stress, On Edge	ASTM D695	2,106 lbf/in²	14.5 MPa
Compressive Strength, Peak Stress, Upright	ASTM D695	4,031 lbf/in²	27.8 MPa

THERMAL PROPERTIES	TEST METHOD	ENGLISH	METRIC
Heat Deflection (HDT) @ 66 psi, 0.125" unannealed	ASTM D648	250°F	121°C
Heat Deflection (HDT) @ 264 psi, 0.125" unannealed	ASTM D648	226°F	108°C
Glass Transition Temperature (Tg)	SSYS DSC	270°F	132°C
Coefficient of Thermal Expansion (Up to 100°C, xyflow)	ASTM E831	59 µin/(in-°F)	107 µm/(m·°C)
Coefficient of Thermal Expansion (Up to 100°C, xzflow)	ASTM E831	49 µin/(in-°F)	88 µm/(m·°C)
Coefficient of Thermal Expansion (100-130°C, xyflow)	ASTM E831	98 µin/(in-°F)	177 µm/(m·°C)
Coefficient of Thermal Expansion (100-130°C, xzflow)	ASTM E831	42 µin/(in-°F)	76 µm/(m·°C)

SUGGESTED CURE CYCLE PARAMETERS	TEMPERATURE A	TEMPERATURE B	PRESSURE A	PRESSURE B
Temperature	250°F (121°C)	210°F (98°C)	29 in-Hg (101.3 kPa)	183 in-Hg (620 kPa)

**All values validated using three linked contours and permeable triangular fill with an air gap of 0.25 in (6 mm).*

3D PRINTER AVAILABILITY	SUPPORT TECHNOLOGY	SLICE HEIGHT	TIPS
Fortus 450mc	ST-130_S	0.013" (0.333 mm)	Model: T20B Support: T20
Fortus 900mc			

STRATASYS.COM

ST-130

SACRIFICIAL TOOLING MATERIAL

At the core:
Advanced FDM technology

Fortus 3D Printers are based on FDM® (fused deposition modeling) technology. FDM is the industry's leading additive manufacturing technology, and the only one that uses production-grade thermoplastics, enabling the most durable parts.

Fortus 3D Printers use a wide range of thermoplastics with advanced mechanical properties so your parts can endure high heat, caustic chemicals, sterilization and high impact applications.

No special facilities needed

You can install a Fortus 3D Printer just about anywhere. No special venting is required because Fortus systems don't produce noxious fumes, chemicals or waste.

No special skills needed

Fortus 3D Printers are easy to operate and maintain compared to other additive fabrication systems because there are no messy powders to handle and contain. They're so simple, an operator can be trained to operate a Fortus system in less than 30 minutes.

Get your benchmark on the future of manufacturing

Fine details. Smooth surface finishes. Accuracy. Strength. The best way to see the advantages of a Fortus 3D Printer is to have your own part built on a Fortus system. Get your free part at: stratasys.com.

Figure 1: FDM sacrificial tooling begins with a 3D printed tool, which features a standard fill pattern designed to promote fluid flow during the tool removal process and provide adequate strength during elevated temperature, high pressure cure cycles.

Figure 2: The composite material is then wrapped around the sacrificial tool as shown. Once the part is fully formed and cured, the tool is ready for wash-out.

Figure 3: The FDM tool is easily removed, hands free, leaving the final composite part.

stratasys

E info@stratasys.com / STRATASYS.COM
ISO 9001:2008 Certified

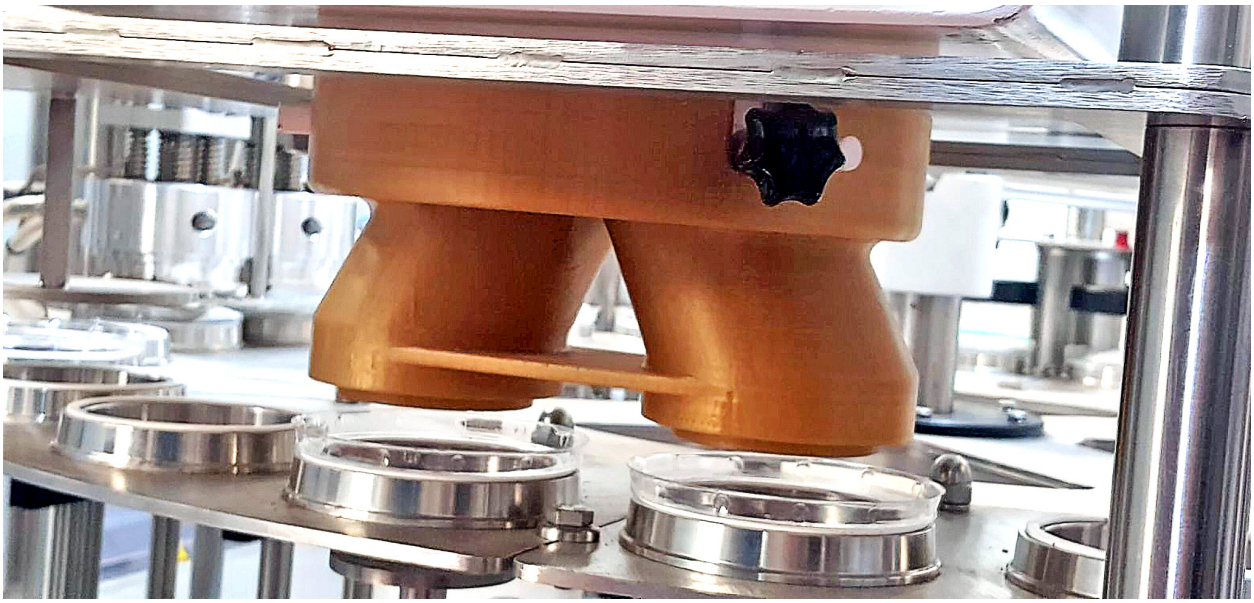
HEADQUARTERS
7665 Commerce Way, Eden Prairie, MN 55344
+1 888 480-3548 (US Toll Free)
+1 952 937-3000 (Intl)
+1 952 937-0070 (Fax)

2 Holtzman St., Science Park, PO Box 2496
Rehovot 76124, Israel
+972 74 745-4000
+972 74 745-5000 (Fax)

ULTEM™ 1010 Resin

FDM Thermoplastic Filament

The information presented are typical values intended for reference and comparison purposes only.
They should not be used for design specifications or quality control purposes.



Overview

ULTEM™ 1010 resin is a high-performance FDM® polyetherimide (PEI) thermoplastic. It exhibits high tensile strength in addition to broad chemical resistance and excellent thermal stability. Its high heat resistance makes it autoclave-capable for applications involving sterilization and composite lay-up tooling.

This material is available in both general-purpose and certified grades (CG). ULTEM™ 1010 resin is used with breakaway support material and is available in natural color.

Contents:

Ordering Information 3
Physical Properties 4
Mechanical Properties 5
Outgassing 7
Appendix 8

Ordering Information

Table 1. Printer and Support Material Compatibility

Printer	Model Tip (Slice)	Support Material	Support Tip
Fortus 450mc™	T14 (10 slice) T20 (13 slice)	1010 support (breakaway)	T16 (10, 13 slice)
F900™	T14 (10 slice) T20 (13 slice) T40A (20 slice)	1010 support (breakaway)	T16 (10, 13 slice) T20 (20 slice)

Build Sheet

High Temperature

- 0.02 x 26 x 38 in. (0.51 x 660 x 965 mm)
- 0.02 x 16 x 18.5 in. (0.51 x 406 x 470 mm)

Table 2. ULTEM™ 1010 Resin Ordering Information

Part Number	Description
Filament Canisters[1] [2]	
355-02330	ULTEM™ 1010 resin, 92.3 cu in - Plus
355-02320	ULTEM™ 1010 resin CG, 92.3 cu in - Plus
312-22100	ULTEM™ 1010 resin, 92.3 cu in - Classic
312-22000	ULTEM™ 1010 resin CG, 92.3 cu in - Classic
355-03240	ULTEM™ Support, 92.3 cu in. - Plus
310-31000	ULTEM™ Support, 92.3 cu in. - Classic
Printer Consumables	
511-12000	T14 tip
511-10701	T20 tip
511-10750	T40A tip
511-10401	T16 tip
325-00275-S	High Temperature build sheet, 0.02x26x38 in. (0.51x660x965 mm)
325-00475-S	High Temperature build sheet, 0.02x16x18.5 in. (0.51x406x470 mm)
310-00300	High Temperature build sheet, 0.03x16x18.5 in. (0.76x406x470 mm)

[1] Classic canisters are compatible with Fortus 900mc printers prior to s/n L502.

[2] Plus canisters are compatible with all Fortus 450mc, all Stratasys F900, and Fortus 900mc printers s/n L502 and up.

Physical Properties

Values are measured as printed. XY, XZ, and ZX orientations were tested. For full details refer to the Stratasys Materials Test Report (immediate download upon clicking the link). DSC and TMA curves can be found in the Appendix.

Table 3. ULTEM™ 1010 Resin Physical Properties

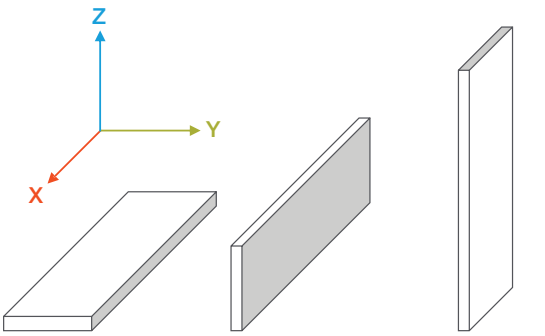
Property	Test Method	Typical Values	
		XY	XZ/ZX
HDT @ 66 psi	ASTM D648 Method B	214.1 °C (417.3 °F)	
HDT @ 264 psi	ASTM D648 Method B	212.2 °C (413.9 °F)	
Tg	ASTM D7426 Inflection Point	209.37 °C (408.87 °F)	
Mean CTE	ASTM E831 (-50 °C to 60 °C)	36.08 µm/[m*°C] (20.04 µin/[in*°F])	-
	ASTM E831 (60 °C to 205 °C)	29.81 µm/[m*°C] (16.56 µin/[in*°F])	-
	ASTM E831 (-50 °C to 110 °C)	-	32.50 µm/[m*°C] (18.06 µin/[in*°F])
	ASTM E831 (110 °C to 165 °C)	-	16.19 µm/[m*°C] (8.995 µin/[in*°F])
	ASTM E831 (165 °C to 200 °C)	-	4.291 µm/[m*°C] (2.384 µin/[in*°F])
Volume Resistivity	ASTM D257	>7.00*10^14 Ω*cm	
Dielectric Constant	ASTM D150 1 kHz test condition	2.841	2.888
	ASTM D150 2 MHz test condition	3.089	3.156
Dissipation Factor	ASTM D150 1 kHz test condition	-0.002	-0.002
	ASTM D150 2 MHz test condition	0.000	0.000
Thermal Conductivity	ASTM E1952 @0C	0.2430 W/m*K 0.1404 BTU/(hr*ft*F)	
Thermal Conductivity	ASTM E1952 @30C	0.2420 W/m*K 0.1399 BTU/(hr*ft*F)	
Thermal Conductivity	ASTM E1952 @60C	0.2426 W/m*K 0.1399 BTU/(hr*ft*F)	
Thermal Conductivity	ASTM E1952 @90C	0.2417 W/m*K 0.1402 BTU/(hr*ft*F)	
Thermal Diffusivity	ASTM E1952 @0C	0.158 mm^2/s 2.45*10^-4 in^2/s	
Thermal Diffusivity	ASTM E1952 @30C	0.141 mm^2/s 2.19*10^-4 in^2/s	
Thermal Diffusivity	ASTM E1952 @60C	0.130 mm^2/s 2.02*10^-4 in^2/s	
Thermal Diffusivity	ASTM E1952 @90C	0.121 mm^2/s 1.88*10^-4 in^2/s	
Specific Gravity	ASTM D257 @23 °C	1.29	
UL Flammability	ANSI/UL 746B	V0- Blue Card #E345258	

Mechanical Properties

ULTEM™ 1010 resin samples were printed with a 0.010 in. (0.254 mm) layer height on the F900. For the full test procedure please see the Stratasys Materials Test Procedure (immediate download upon clicking the link).

Print Orientation

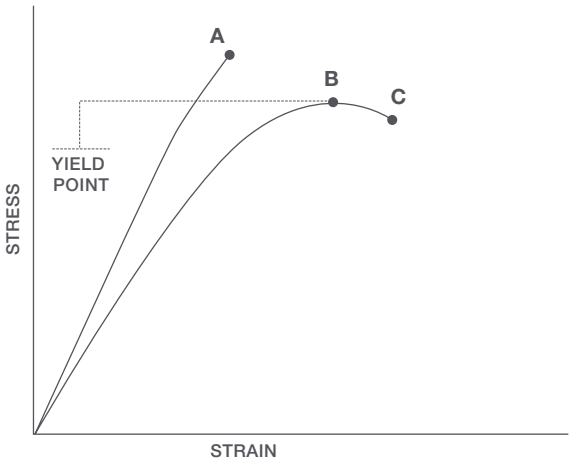
Parts created using FDM are anisotropic as a result of the printing process. Below is a reference of the different orientations used to characterize the material.



Flat (XY) On Edge (XZ) Upright (ZX)

Tensile Curves

Due to the anisotropic nature of FDM, tensile curves look different depending on orientation. Below is a guide of the two types of curves seen when printing tensile samples and what reported values mean.



A = Tensile at break, elongation at break (no yield point)
B = Tensile at yield, elongation at yield
C = Tensile at break, elongation at break

Table 4. ULTEM™ 1010 Resin Mechanical Properties (F900 - T14 Tip)

		XZ Orientation[1]	ZX Orientation[1]
Tensile Properties: ASTM D638			
Yield Strength	MPa	No yield	No yield
	psi		
Elongation @ Yield	%	No yield	No yield
Strength @ Break	MPa	79.2 (4.9)	28.2 (8.8)
	psi	11500 (710)	4080 (1300)
Elongation @ Break	%	4.0 (0.42)	1.1 (0.45)
Modulus (Elastic)	GPa	3.04 (0.18)	3.00 (0.45)
	ksi	441 (27)	435 (65)
Flexural Properties: ASTM D790, Procedure A			
Strength @ Break	MPa	No break	81.6 (13)
	psi	No break	11800 (1900)
Strength @ 5% Strain	MPa	128 (1.8)	-
	psi	18600 (270)	-
Strain @ Break	%	No break	3.19 (0.53)
Modulus	MPa	2.91 (0.049)	2.64 (0.13)
	ksi	422 (7.0)	383 (19)
Compression Properties: ASTM D695			
Yield Strength	MPa	245 (50)	438 (31)
	psi	35600 (7200)	63500 (4500)
Modulus	GPa	2.93 (0.14)	3.23 (0.57)
	ksi	425 (20)	468 (83)
Impact Properties: ASTM D256, ASTM D4812			
Notched	J/m	26.6 (3.5)	21.7 (4.7)
	ft*lb/in.	0.498 (0.065)	0.407 (0.089)
Unnotched	J/m	260 (57)	68.0 (29.8)
	ft*lb/in.	4.87 (1.1)	1.27 (0.56)

[1] Values in parentheses are standard deviations.

Outgassing

ULTEM™ 1010 resin, natural, was printed with a T14 tip on a Stratasys Fortus 450mc and tested per ASTM E595-15. Full report available upon request.

Table 5. ULTEM™ 1010 Resin Outgassing Test Results

Sample	TML (%)	CVCM (%)	WVR (%)
ULTEM™ 1010 Resin, Natural, T14 tip, Flat (XY)	0.55	0.02	0.39
ULTEM™ 1010 Resin, Natural, T14 tip, Upright (ZX)	0.58	0.03	0.33
Testing Observations(1)			
Visible Consendate	No	Opaque	N/A
Precent Convered	0%	Interference Fringes	N/A
Thin	N/A	Colored Fringes	N/A
Heavy	N/A	Sample appearance after test	No change
Transparent	N/A		

(1) Observations apply to all tested samples

Appendix

Figure 1. 2nd heating scan DSC data for the ULTEM™ 1010 resin Flat (XY) sample.

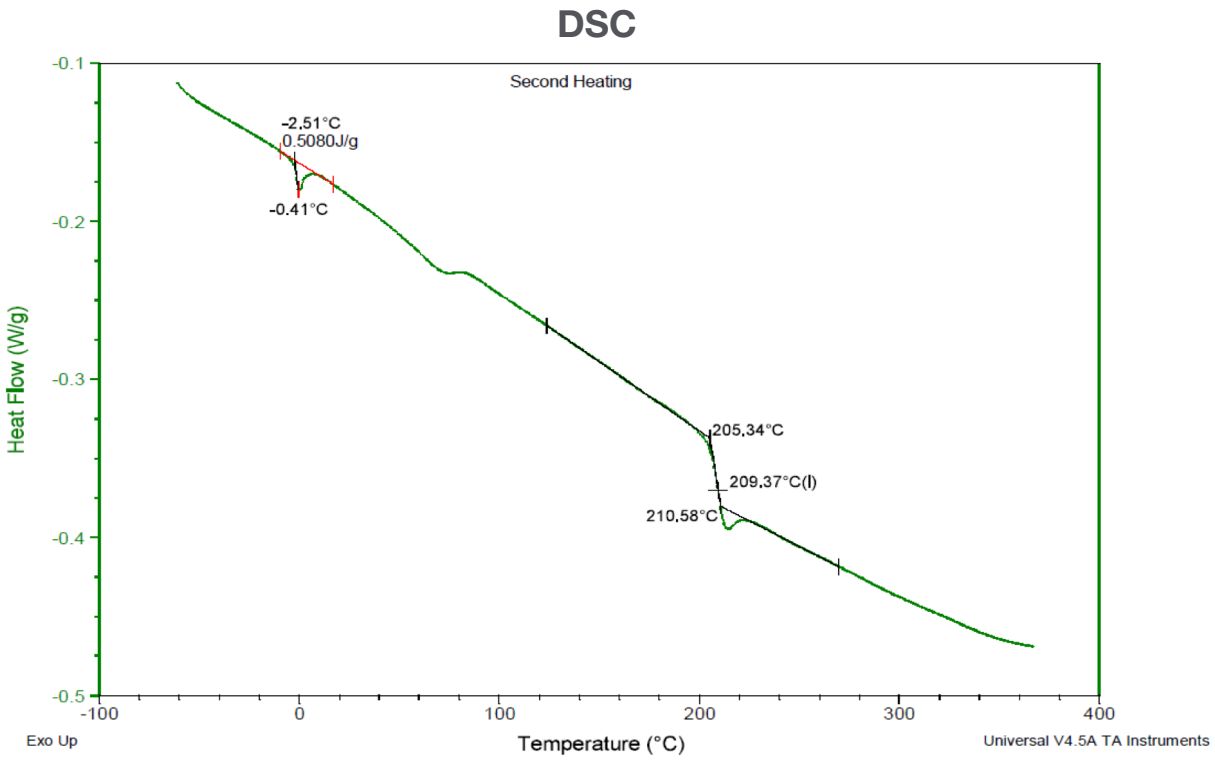


Figure 2. – Dimension change data as a function of temperature for the ULTEM™ 1010 resin Flat (XY) sample.

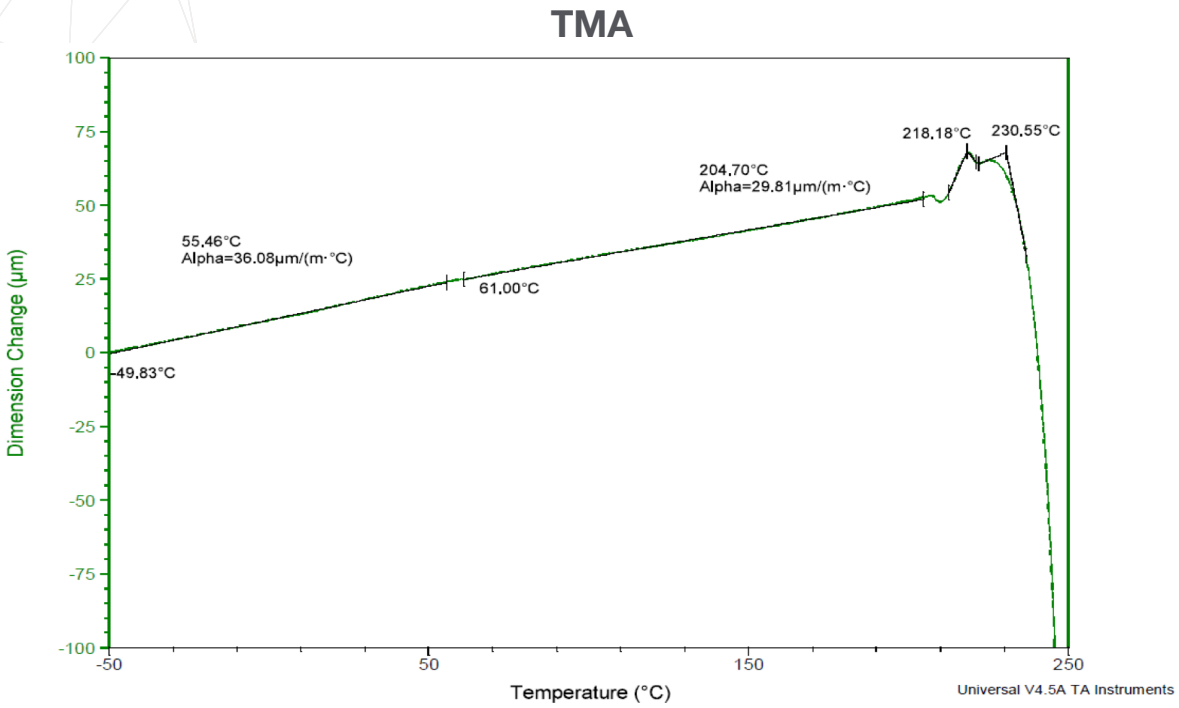


Figure 3. Dimension change data as a function of temperature for the ULTEM™ 1010 resin On Edge (XZ) sample.

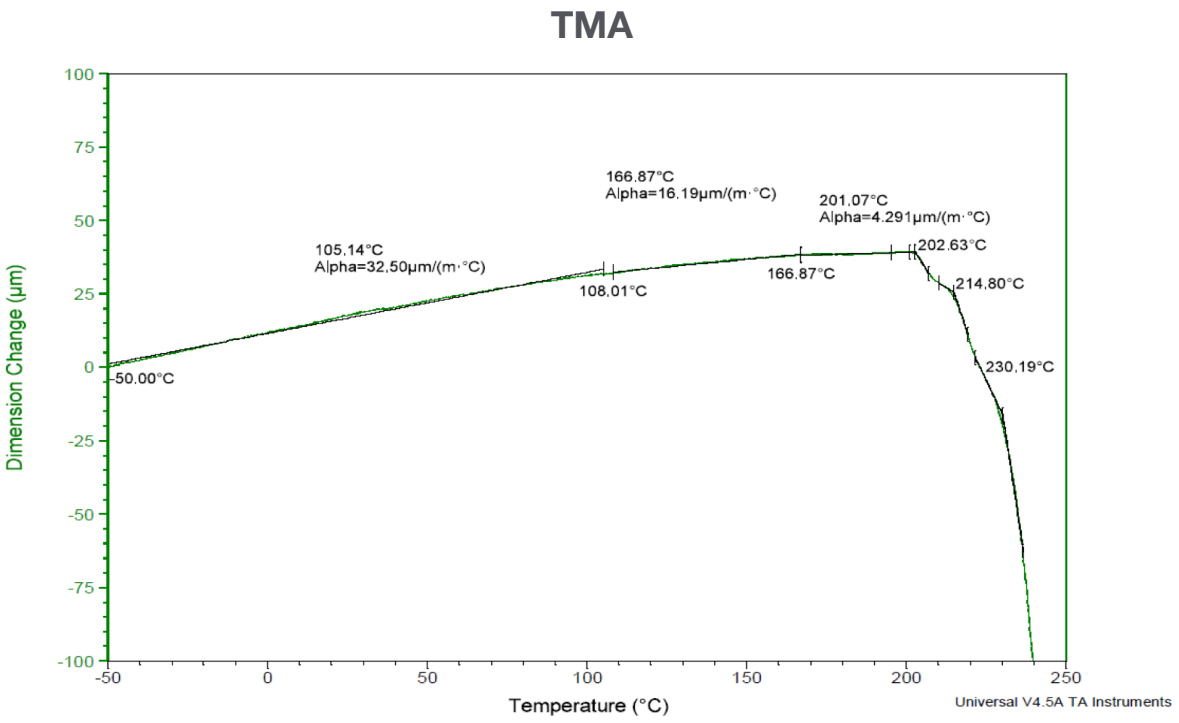
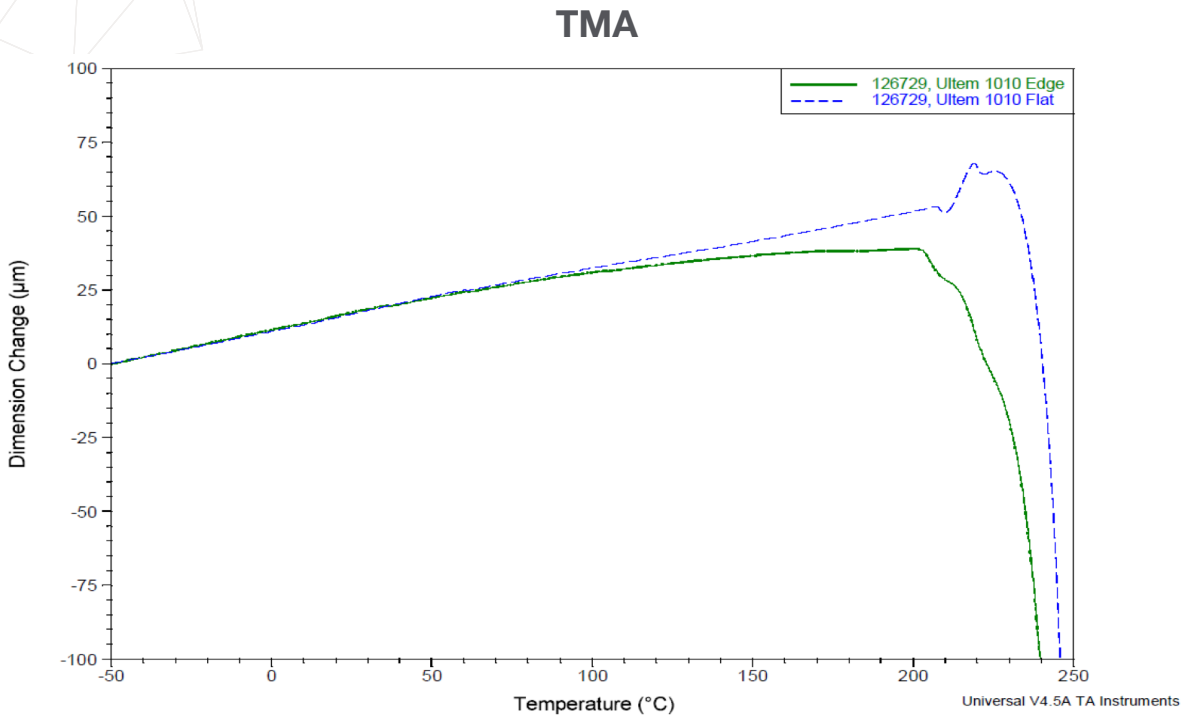


Figure 4. – Overlay of the dimension change data for the Flat (XY) and On Edge (XZ) ULTEM™ 1010 resin samples.



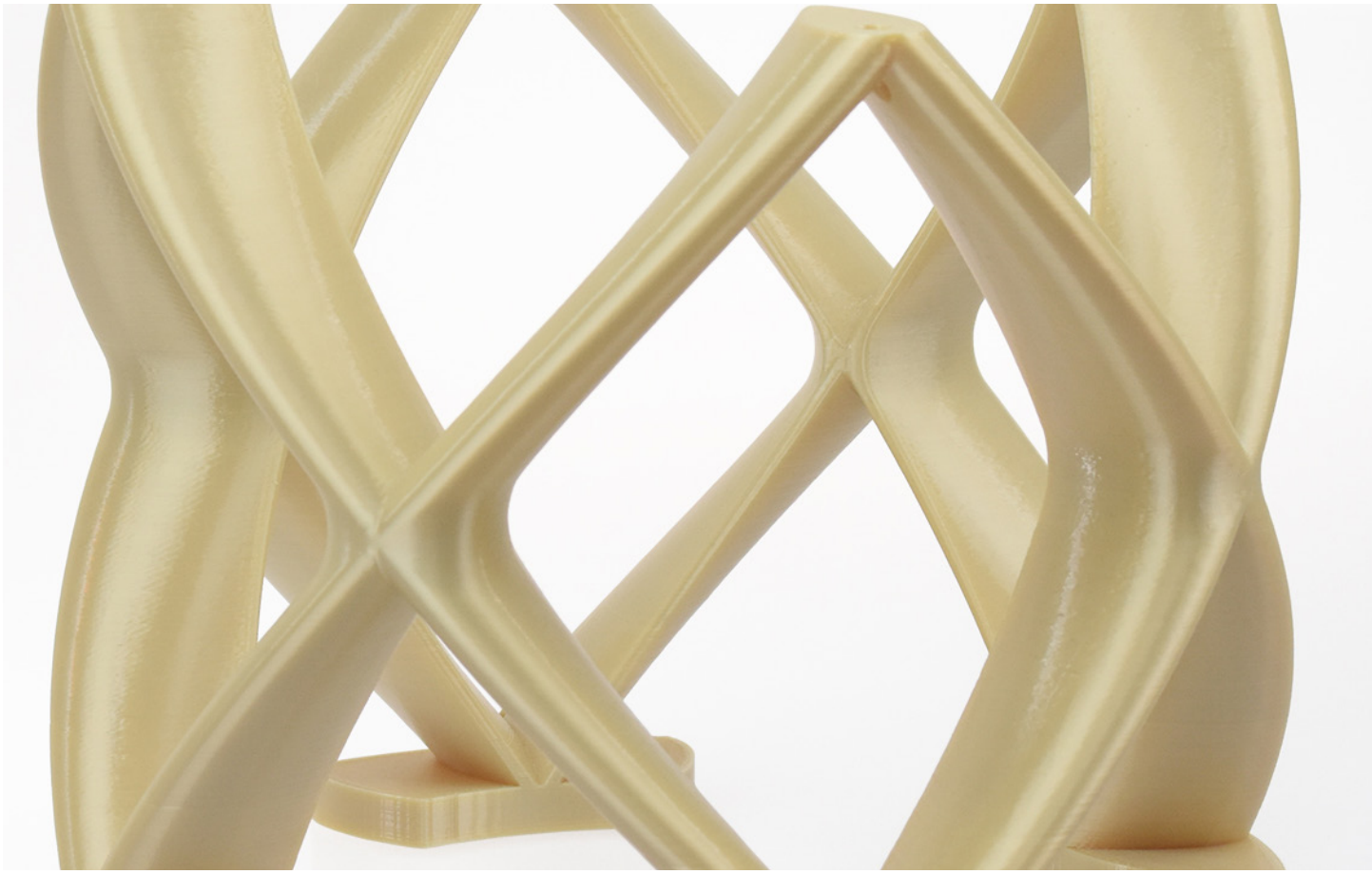
Stratasys Headquarters

7665 Commerce Way,
Eden Prairie, MN 55344
+1 800 801 6491 (US Toll Free)
+1 952 937-3000 (Intl)
+1 952 937-0070 (Fax)

1 Holtzman St., Science Park,
PO Box 2496
Rehovot 76124, Israel
+972 74 745 4000
+972 74 745 5000 (Fax)

stratasys.com
ISO 9001:2015 Certified

ULTEM™ 9085 Resin



FDM® Thermoplastic Filament
Fit for High-Performance Applications

The information presented are typical values intended for reference and comparison purposes only.
They should not be used for design specifications or quality control purposes.

Overview

ULTEM™ 9085 resin filament is a PEI (polyetherimide) thermoplastic FDM material. It features a high strength-to-weight ratio, high thermal and chemical resistance, and meets multiple aerospace and railway industry standards for flame, smoke and toxicity (FST) characteristics.

ULTEM™ 9085 resin CG (Certified Grade - only available in Natural) meets more stringent test criteria and possesses documented traceability from filament back to raw material lot number. Included documentation:

- Certificate of Analysis – for both raw material and filament are supplied, documenting test results and identification to match filament manufacturing lot number to raw material batch number.
- Certificate of Conformance – confirms that the material is manufactured in compliance to approved Stratasys and industry specifications.

Typical applications include production parts and functional prototypes. Available colors are natural and black.

Contents:

Overview 2

Ordering Information 3

Physical Properties 4

Mechanical Properties 5

Flame, Smoke, and Toxicity Test Results 10

Outgassing 13

Fire Protection for Railway Vehicles 13

Fire Protection of Buses 15

Appendix 16

Ordering Information

Table 1. Printer and Support Material Compatibility

Printer	Model Tip	Support Material	Support Tip
Fortus 450	T16 (10 slice) T20 (13 slice)	9085 Support	T16 (all slices)
F900	T16 (10 slice) T16A (10 slice) T20 (13 slice)	9085 Support	T16 (all slices)

Build Sheet

High temperature

- 0.02 x 26 x 38 in. (0.76 x 660 x 965 mm)
- 0.02 x 16 x 18.5 in (0.51 x 406 x 470 mm)

Table 2. ULTEM™ 9085 Resin Ordering Information

Part Number	Description
Filament Canisters[1][2]	
355-02310	ULTEM™ 9085 resin natural, 92 cu in – Plus
355-08310	ULTEM™ 9085 resin natural, 184 cu in – Plus
355-23101	ULTEM™ 9085 resin CG, 92 cu in – Plus
355-02311	ULTEM™ 9085 resin black, 92 cu in – Plus
355-03220	ULTEM™ 9085 resin BASS, 92 cu in – Plus
312-20001	ULTEM™ 9085 resin CG, 92 cu in – Classic
312-20000	ULTEM™ 9085 resin natural, 92 cu in – Classic
312-20018	ULTEM™ 9085 resin natural, 184 cu in – Classic
312-20200	ULTEM™ 9085 resin black, 92 cu in – Classic
310-30600	ULTEM™ 9085 resin BASS, 92 cu in - Classic
Printer Consumables	
511-10401	T16 tip, 0.010 in. (0.254 mm) layer height
511-10410	T16A tip, 0.010 in. (0.254 mm) layer height
511-10701	T20 tip, 0.013 in. (0.330 mm) layer height
325-00475[3]	900 high temperature build sheet, 0.02x26x38 in (0.51x660x965 mm)
325-00275[4]	900 & 450 high temperature build sheet, 0.02x16x18.5 in (0.51x406x470 mm)
310-00300[5]	High Temperature build sheet, 0.03x16x18.5 in. (0.76x406x470 mm)

(1) Classic canisters are compatible with all Fortus 400mc and Fortus 900mc printers prior to s/n L502
(2) Plus canisters are compatible with all Fortus 450mc, all Stratasys F900, and Fortus 900mc printers s/n L502 and up
(3) Compatible with Stratasys F900 and Fortus 900mc
(4) Compatible with Fortus 450mc, Stratasys F900 and Fortus 900mc
(5) Compatible with Fortus 400mc

Physical Properties

Values are measured as printed. XY, XZ, and ZX orientations were tested.

For full details refer to the Stratasys Materials Test Procedure on www.stratasys.com.

DSC and TMA curves can be found in the Appendix.

Table 3. ULTEM™ 9085 Resin Physical Properties (Tested with Natural ULTEM(TM) 9085 and T16 tip)

Property	Test Method	Typical Values	
		XY	XZ/ZX
HDT @ 66psi	ASTM D648 Method B	176.9 °C (350.4 °F)	
HDT @ 264psi	ASTM D648 Method B	172.9 °C (343.2 °F)	
Tg	ASTM D7426 Inflection Point	177.32 °C (351.18 °F)	
Mean CTE (TAN)	ASTM E831 (-50C to 60C)		44.45 µm/[m*°C] 24.69 µin/[in*°F]
Mean CTE (TAN)	ASTM E831 (60C to 160C)		32.31µm/[m*°C] 17.95 µin/[in*°F]
Mean CTE (TAN)	ASTM E831 (-50C to 80C)	44.89 µm/[m·°C] (24.94 µin/[in·°F])	
Mean CTE (TAN)	ASTM E831 (80C to 160C)	31.35 µm/[m·°C] (17.42 µin/[in·°F])	
Mean CTE (BLACK)	ASTM E831 (-50C to 30C)		47.79 µm/[m*°C] 26.55 µin/[in*°F]
Mean CTE (BLACK)	ASTM E831 (30C to 165C)		38.55 µm/[m*°C] 21.42 µin/[in*°F]
Mean CTE (BLACK)	ASTM E831 (-50C to 80C)	51.88 µm/[m*°C] 28.82 µin/[in*°F]	
Mean CTE (BLACK)	ASTM E831 (80C to 160C)	40.2 µm/[m*°C] 22.33 µin/[in*°F]	
Volume Resistivity	ASTM D257	> $6.89*10^{15}$ Ω·cm	
Dielectric Constant	ASTM D150 1 kHz test condition	2.80	2.87
Dielectric Constant	ASTM D150 2 MHz test condition	2.65	2.73
Dissipation Factor	ASTM D150 1 kHz test condition	0.002	0.002
Dissipation Factor	ASTM D150 2 MHz test condition	0.010	0.010
Thermal Conductivity	ASTM E1952 @0C	0.2136 W/m*K 0.1234 BTU/(hr*ft*F)	
Thermal Conductivity	ASTM E1952 @30C	0.2109 W/m*K 0.1219 BTU/(hr*ft*F)	
Thermal Conductivity	ASTM E1952 @60C	0.2111 W/m*K 0.1220 BTU/(hr*ft*F)	
Thermal Conductivity	ASTM E1952 @90C	0.2095 W/m*K 0.1211 BTU/(hr*ft*F)	
Thermal Diffusivity	ASTM E1952 @0C	0.148 mm^2/s 2.29*10^-4 in^2/s	
Thermal Diffusivity	ASTM E1952 @30C	0.132 mm^2/s 2.05*10^-4 in^2/s	
Thermal Diffusivity	ASTM E1952 @60C	0.121 mm^2/s 1.88*10^-4 in^2/s	
Thermal Diffusivity	ASTM E1952 @90C	0.111 mm^2/s 1.72*10^-4 in^2/s	
Specific Gravity	ASTM D792 @ 23C	1.27	
UL Flammability(1)	ANSI/UL 746B	V0 – Blue Card #E345258	

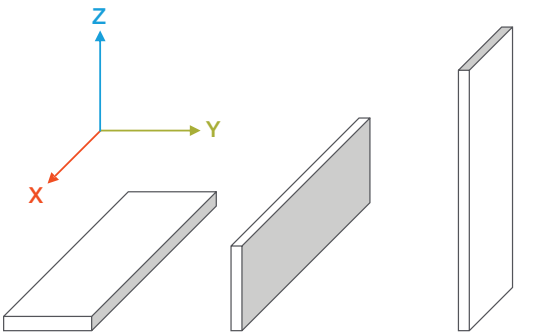
(1) Applies to the natural version of ULTEM™ 9085 resin only

Mechanical Properties

Samples, natural and black, were printed with 0.010 in. (0.254 mm) and 0.013 in. (0.330 mm) layer heights on the F900.
For the full test procedure please see the Stratasys Materials Test Procedure on www.stratasys.com.

Print Orientation

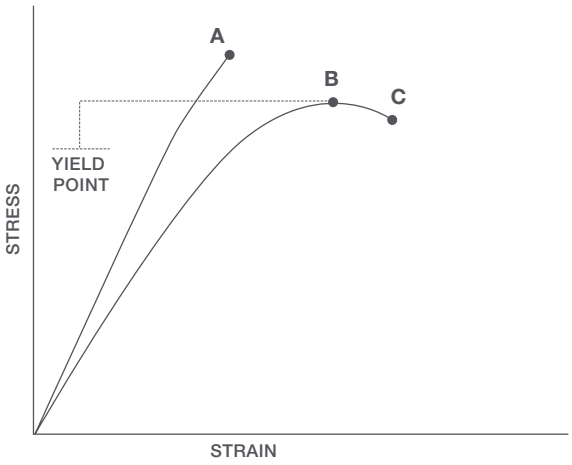
Parts created using FDM® are anisotropic as a result of the printing process. Below is a reference of the different orientations used to characterize the material.



Flat (XY) On Edge (XZ) Upright (ZX)

Tensile Curves

Due to the anisotropic nature of FDM, tensile curves look different depending on orientation. Below is a guide of the two types of curves seen when printing tensile samples and what reported values mean.



A = Tensile at break, elongation at break (no yield point)
B = Tensile at yield, elongation at yield
C = Tensile at break, elongation at break

Table 4. ULTEM™ 9085 Resin Natural Mechanical Properties (F900 - T16 tip)

		XZ Orientation[1]	ZX Orientation[1]
Tensile Properties: ASTM D638			
Yield Strength	MPa	69.2 (1.0)	No yield
	psi	10000 (150)	No yield
Elongation @ Yield	%	5.4 (0.50)	No yield
Strength @ Break	MPa	68.1 (1.6)	39.4 (8.7)
	psi	9870 (230)	5710 (1300)
Elongation @ Break	%	5.4 (0.50)	1.9 (0.51)
Modulus (Elastic)	GPa	2.52 (0.062)	2.41 (0.15)
	ksi	365 (8.9)	350 (22)
Flexural Properties: ASTM D790, Procedure A			
Strength @ Break	MPa	104 (2.2)	73.1 (13)
	psi	15000 (320)	10600 (1900)
Strain @ Break	%	No break	3.67 (0.55)
Modulus	GPa	2.40 (0.032)	2.13 (0.081)
	ksi	348 (4.6)	309 (12)
Compression Properties: ASTM D695			
Yield Strength	MPa	139 (9.4)	342 (27)
	psi	20100 (1400)	49600 (390)
Modulus	GPa	2.22 (0.047)	2.28 (0.080)
	ksi	321 (6.8)	331 (12)
Impact Properties: ASTM D256, ASTM D4812			
Izod, Notched	J/m	88.5 (21)	39.2 (4.3)
	ft*lb/in	1.66 (0.40)	0.735 (0.080)
Izod, Unnotched	J/m	647 (66)	187 (42)
	ft*lb/in	12.1 (1.2)	3.51 (0.79)

(1) Values in parentheses are standard deviations

Table 5. ULTEM™ 9085 Resin Natural Mechanical Properties (F900 - T16A tip)[1]

		XZ Orientation	ZX Orientation
Tensile Properties: ASTM D638			
Strength @ 0.2% offset yield	MPa	45.2	38.2
	psi	6560	5540
Ultimate Strength	MPa	77.1	59.0
	psi	11200	8600
Modulus (Elastic)	GPa	2.62	2.39
	ksi	377	347
Flexural Properties: ASTM D790, Procedure A			
Ultimate Strength	MPa	98.3	80.3
	psi	14300	11600
Modulus	GPa	2.63	2.26
	ksi	381	328
Compression Properties: ASTM D695			
Strength @ 0.2% offset yield	MPa	78.9	60.1
	psi	11400	8710
Modulus	GPa	2.98	266
	ksi	433	386
Impact Properties: ASTM D256, ASTM D4812			
Izod, Notched	J/m	73.7	69.3
	ft*lb/in	1.4	1.3

(1) For full details refer to the Stratasys ULTEM™ 9085 resin report published on the NIAR website

Table 6. ULTEM™ 9085 Resin Natural Mechanical Properties (F900 - T20 tip)

		XZ Orientation[1]	ZX Orientation[1]
Tensile Properties: ASTM D638			
Yield Strength	MPa	68.5 (0.46)	No yield
	psi	9930 (67)	
Elongation @ Yield	%	5.8 (0.044)	No yield
Strength @ Break	MPa	67.8 (0.66)	38.9 (3.7)
	psi	9840 (95)	5640 (530)
Elongation @ Break	%	5.7 (0.32)	2.5 (0.35)
Modulus (Elastic)	GPa	2.31 (0.056)	1.98 (0.16)
	ksi	335 (8.1)	287 (23)
Flexural Properties: ASTM D790, Procedure A			
Strength @ Break	MPa	102 (1.0)	58.8 (8.8)
	psi	14800 (150)	8530 (1300)
Strain @ Break	%	No break	3.25 (0.57)
Modulus	GPa	2.39 (0.021)	1.93 (0.045)
	ksi	346 (3.1)	280 (6.5)
Compression Properties: ASTM D695			
Yield Strength	MPa	86.5 (2.8)	209 (6.6)
	psi	12500 (410)	30400 (960)
Modulus	GPa	1.60 (0.046)	2.00 (0.072)
	ksi	232 (6.7)	290 (10)
Impact Properties: ASTM D256, ASTM D4812			
Izod, Notched	J/m	124 (35)	36.6 (7.6)
	ft*lb/in	2.31 (0.66)	0.685 (0.14)
Izod, Unnotched	J/m	952 (130)	141 (35)
	ft*lb/in	17.8 (2.4)	2.65 (0.66)

(1) Values in parentheses are standard deviations

Table 7. ULTEM™ 9085 Resin Black Mechanical Properties (F900 - T16 tip)

		XZ Orientation[1]	ZX Orientation[1]
Tensile Properties: ASTM D638			
Yield Strength	MPa	71.7 (1.6)	No yield
	psi	10,400 (240)	
Elongation @ Yield	%	5.5 (0.27)	No yield
Strength @ Break	MPa	69.8 (1.7)	41.4 (9.0)
	psi	10100 (240)	6000 (1300)
Elongation @ Break	%	5.4 (0.65)	2.1 (0.58)
Modulus (Elastic)	GPa	2.54 (0.050)	2.42 (0.16)
	ksi	368 (7.2)	351 (23)
Flexural Properties: ASTM D790, Procedure A			
Strength @ Break	MPa	107 (3.4)	72.1 (5.9)
	psi	15500 (490)	10500 (860)
Strain @ Break	%	No break	3.78 (0.39)
Modulus	GPa	2.47 (0.059)	2.11 (0.039)
	ksi	358 (8.6)	305 (5.7)
Compression Properties: ASTM D695			
Yield Strength	MPa	142 (9.1)	349 (24)
	psi	20600 (1300)	50600 (350)
Modulus	GPa	2.27 (0.043)	2.37 (0.097)
	ksi	329 (6.3)	343 (14)
Impact Properties: ASTM D256, ASTM D4812			
Izod, Notched	J/m	94.8 (22)	37.0 (8.3)
	ft*lb/in	1.78 (0.4)	0.693 (0.16)
Izod, Unnotched	J/m	771 (140)	169 (54)
	ft*lb/in	14.4 (2.7)	3.16 (1.0)

(1) Values in parentheses are standard deviations

Flame, Smoke, and Toxicity

ULTEM™ 9085 resin, natural (T20 tip and T16A tip) and black (T16 tip), printed on the Stratasys F900 and tested per 14 CFR 25.853, BSS 7238 and 7239, and AITM 2.0007B and 3.0005. The testing done establishes that this material **meets requirements** for:

- 60s and 12s Vertical Burn
- 15s Horizontal Burn
- Toxic Gas Emission
- Smoke Density
- Heat Release Rate of Cabin Materials

Table 8. ULTEM™ 9085 Resin Flame, Smoke, and Toxicity Test Results

	Avg Time to Extinguish (seconds)	Avg Burned Length (inches)	Drip Time to Extinguish (seconds)
12 Second Vertical Ignition per 14 CFR 25.853(a), Appendix F, Part I, Paragraph (a)(1)(ii)			
ULTEM™ 9085 Resin, Natural, T20 Tip, Build XZ	1.6	0.2	0 (no drips)
ULTEM™ 9085 Resin, Natural, T20 Tip, Build ZX	1.7	0.5	0 (no drips)
ULTEM™ 9085 Resin, Natural, T16A Tip, Build XY	2.0	0.2	0 (no drips)
ULTEM™ 9085 Resin, Natural, T16A Tip, Build XZ	1.5	0.2	0 (no drips)
ULTEM™ 9085 Resin, Natural, T16A Tip, Build ZX	2.0	0.2	0 (no drips)
ULTEM™ 9085 Resin, Black, T16 Tip, Build XZ	1.1	0.3	0 (no drips)
ULTEM™ 9085 Resin, Black, T16 Tip, Build ZX	<1	0.4	0 (no drips)
60 Second Vertical Ignition per 14 CFR 25.853(a), Appendix F, Part I, Paragraph (a)(1)(i)			
ULTEM™ 9085 Resin, Natural, T20 Tip, Build XZ	1.5	1.8	0 (no drips)
ULTEM™ 9085 Resin, Natural, T20 Tip, Build ZX	<1	1.9	0 (no drips)
ULTEM™ 9085 Resin, Natural, T16A Tip, Build XY	<1	0.4	0 (no drips)
ULTEM™ 9085 Resin, Natural, T16A Tip, Build XZ	3.6	0.6	0 (no drips)
ULTEM™ 9085 Resin, Natural, T16A Tip, Build ZX	<1	0.4	0 (no drips)
ULTEM™ 9085 Resin, Black, T16 Tip, Build XZ	<1	1.2	0 (no drips)
ULTEM™ 9085 Resin, Black, T16 Tip, Build ZX	<1	1.5	0 (no drips)
	Avg Burn Rate (in/min)		
15 Second Horizontal Ignition per 14 CFR 25.853(a), Appendix F, Part I, Paragraph (a)(1)(iv)(v)			
ULTEM™ 9085 Resin, Natural, T20 Tip, Build XZ	0		
ULTEM™ 9085 Resin, Natural, T20 Tip, Build ZX	0		
ULTEM™ 9085 Resin, Natural, T16A Tip, Build XY	0		
ULTEM™ 9085 Resin, Natural, T16A Tip, Build XZ	0		
ULTEM™ 9085 Resin, Natural, T16A Tip, Build ZX	0		
ULTEM™ 9085 Resin, Black, T16 Tip, Build XZ	0		
ULTEM™ 9085 Resin, Black, T16 Tip, Build ZX	0		

Table 8. ULTEM™ 9085 Resin Flame, Smoke, and Toxicity Test Results

	Test Mode	Average D_s (maximum) within 4 minutes, ($^4D_{max}$)
Smoke Density per BSS 7238, Rev. C		
ULTEM™ 9085 Resin, Natural, T20 Tip, Build XZ	Flaming	4
ULTEM™ 9085 Resin, Natural, T20 Tip, Build ZX	Flaming	5
ULTEM™ 9085 Resin, Natural, T16A Tip, Build XY	Flaming	4
ULTEM™ 9085 Resin, Natural, T16A Tip, Build ZX	Flaming	4
ULTEM™ 9085 Resin, Black, T16 Tip, Build XZ	Flaming	10
ULTEM™ 9085 Resin, Black, T16 Tip, Build ZX	Flaming	15
Smoke Density per AITM 2.0007B, Issue 3		
ULTEM™ 9085 Resin, Natural, T20 Tip, Build XZ	Flaming	5
ULTEM™ 9085 Resin, Natural, T20 Tip, Build ZX	Flaming	5
ULTEM™ 9085 Resin, Natural, T20 Tip, Build XZ	Non-Flaming	0
ULTEM™ 9085 Resin, Natural, T20 Tip, Build ZX	Non-Flaming	0
ULTEM™ 9085 Resin, Natural, T16A Tip, Build XY	Flaming	5
ULTEM™ 9085 Resin, Natural, T16A Tip, Build ZX	Flaming	6
ULTEM™ 9085 Resin, Natural, T16A Tip, Build XY	Non-Flaming	0
ULTEM™ 9085 Resin, Natural, T16A Tip, Build ZX	Non-Flaming	0
ULTEM™ 9085 Resin, Black, T16 Tip, Build XZ	Flaming	12
ULTEM™ 9085 Resin, Black, T16 Tip, Build ZX	Flaming	14
ULTEM™ 9085 Resin, Black, T16 Tip, Build XZ	Non-Flaming	0
ULTEM™ 9085 Resin, Black, T16 Tip, Build ZX	Non-Flaming	0

	Test Mode	CO ppm	SO_2 ppm	NO_x ppm	HCN ppm	HCl ppm	HF ppm
Toxic Gas Emission per BSS 7239, Rev. A							
ULTEM™ 9085 Resin, Natural, T20 Tip, Build XZ	Flaming	50	0 (NI)	2	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Natural, T20 Tip, Build ZX	Flaming	50	0 (NI)	2	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Natural, T16A Tip, Build XY	Flaming	50	0 (NI)	2	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Natural, T16A Tip, Build ZX	Flaming	50	0 (NI)	2	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Black, T16 Tip, Build XZ	Flaming	100	0 (NI)	1	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Black, T16 Tip, Build ZX	Flaming	75	0 (NI)	1	0 (NI)	0 (NI)	0 (NI)

Table 8. ULTEM™ 9085 Resin Flame, Smoke, and Toxicity Test Results

	Test Mode	CO ppm	SO_2 ppm	NO_x ppm	HCN ppm	HCl ppm	HF ppm
Toxic Gas Emission per AITM 3.0005, Issue 2							
ULTEM™ 9085 Resin, Natural, T20 Tip, Build XZ	Flaming	92	0	2.8	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Natural, T20 Tip, Build ZX	Flaming	102	0	4	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Natural, T20 Tip, Build XZ	Non-Flaming	2.6	0	0	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Natural, T20 Tip, Build ZX	Non-Flaming	2.2	0	0	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Natural, T16A Tip, Build XY	Flaming	61	0	2.3	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Natural, T16A Tip, Build ZX	Flaming	78	0	3.2	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Natural, T16A Tip, Build XY	Non-Flaming	4	0	0	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Natural, T16A Tip, Build ZX	Non-Flaming	5	0	0	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Black, T16 Tip, Build XZ	Flaming	93	0	1	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Black, T16 Tip, Build ZX	Flaming	103	0	3	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Black, T16 Tip, Build XZ	Non-Flaming	2	0	0	0 (NI)	0 (NI)	0 (NI)
ULTEM™ 9085 Resin, Black, T16 Tip, Build ZX	Non-Flaming	2	0	0	0 (NI)	0 (NI)	0 (NI)

	Peak HRR (kW/m^2)	Time to Peak Heat Release (seconds)	2 Minute Total HRR ($kW\text{-}min./m^2$)
Heat Release Rate of Cabin Materials per 14 CFR 25.853(d), Appendix F, Part IV			
ULTEM™ 9085 Resin, Natural, T20 Tip, Build XZ	54.5	73	35.5
ULTEM™ 9085 Resin, Natural, T20 Tip, Build ZX	48.2	66	41.0
ULTEM™ 9085 Resin, Natural, T16A Tip, Build XY	57.0	57	43.7
ULTEM™ 9085 Resin, Natural, T16A Tip, Build ZX	56.6	57	52.8
ULTEM™ 9085 Resin, Black, T16 Tip, Build XZ	55.4	48	32.7
ULTEM™ 9085 Resin, Black, T16 Tip, Build ZX	41.8	51	34.1

Outgassing

ULTEM™ 9085 resin, natural and black, was printed with a T20 and T16 tip on the Stratasys F900 and tested per ASTM E595. Full report available upon request.

Table 9. ULTEM™ 9085 Resin Outgassing Test Results

Sample	TML (%)	CVCM (%)	WVR (%)
ULTEM™ 9085 Resin, Natural, T20 Tip	0.34	0.02	0.35
ULTEM™ 9085 Resin, Natural, T16A Tip	0.37	< 0.01	0.38
ULTEM™ 9085 Resin, Black, T16 Tip	0.33	< 0.01	0.22

Testing Observations[1]			
Visible Condensate	No	Opaque	N/A
Percent Covered	0%	Interference Fringes	N/A
Thin	N/A	Colored Fringes	N/A
Heavy	N/A	Sample appearance after test	No change
Transparent	N/A		

(1) Observations apply to all tested samples

Fire Protection of Railway Vehicles

NFPA 130

ULTEM™ 9085 CG resin was printed with a T16A tip on the Stratasys F900, using single contour and +45/-45 solid rasters, which are typical default settings and tested per NFPA 130.

* It should be noted that products with other wall thicknesses and/or printed at different machines and with different settings (orientation/ filling/ tip size) may perform differently.

* Further testing should be done by the customer to make sure the material fits their final application.

Table 11. ULTEM 9085 CG Resin NFPA 130 Fixed Guideway Transit and Passenger Transit Systems Test Results

Test	Thickness	Performance Criteria	Result	
ASTM E162	12.7 mm	Depends on function of material. Refer to NFPA 130 Table 8.4.1	Is (flat) = 0 Is (upright) = 0	
ASTM E662	20 mm	Depends on function of material. Refer to NFPA 130 Table 8.4.1	Flat, Non-flaming Ds (1.5) = 0 Ds (4.0) = 0	Flat, Flaming Ds (1.5) = 0 Ds (4.0) = 12.3
			Upright, Non-flaming Ds (1.5) = 0 Ds (4.0) = 0	Upright, flaming Ds (1.5) = 0.7 Ds (4.0) = 17
ASTM E1354	25 mm	Average Heat Release Rate < 100 kW/m2 Average Smoke Extinction Area < 500 m2/kg	Flat Average Heat Release Rate: 67.1 kW/m2 Average Smoke Extinction Area: 262.4 m2/kg	
			Upright Average Heat Release Rate: 61.4 kW/m2 Average Smoke Extinction Area: 372.3 m2/kg	

Fire Protection of Railway Vehicles
EN-45545-2

ULTEM™ 9085 CG

ULTEM™ 9085 CG resin was printed with a T16A tip on the Stratasys F900, using single contour and +45/-45 solid rasters, which are typical default settings and tested per EN-45545-2.

The limited testing done establishes that this material meets requirements for:

- R1, R2, R3, R6, R7, R17: HL1/2/3 at 25mm thick in XY and XZ orientations
- R2, R3, R17: HL1/2/3 at 5mm thick in XY orientation
- Not classified at 5mm thick in XZ orientation
- R22: HL1/2 at 0.508 mm thick in XY orientation
- R22: HL1/2/3, 1mm to 10.5mm in XY orientation
- R23: HL1/2/3, 0.508mm to 10.5 mm in XY orientation

* Additional tests are in progress. Please consult Stratasys Application Engineers to learn more.

* It should be noted that products with other wall thicknesses and/or printed at different machines and with different settings (orientation/ filling/ tip size) may perform differently.

* Further testing should be done by the customer to make sure the material fits their final application.

Table 12. ULTEM™ 9085 CG Resin Fire Protection of Railway Vehicles Test Results for R1 requirement set

Test	Results	5mm XY	5mm XZ	25mm XY	25mm XZ
ISO 5659-2 50 kW/m2	Ds(4)	-	-	38	57
	VOF4			62	94
	Dm			228	231
ISO 5659-2 + EN 45545-2 Appendix C 50 kW/m2	ITC 4 minutes	-	-	0.02	0.01
	ITC 8 minutes			0.08	0.06
ISO 5660-1	MAHRE (kW/m²)	-	-	24.1	19.9
ISO 5658-2	CFE (kW/m²)	16.5	12.5	29.9	28.6

Table 13. ULTEM™ 9085 CG Resin Fire Protection of Railway Vehicles Test Results for R22/23 requirement set

Test	Results	0.508mm XY	1mm XY	10.5mm XY
ISO 5659-2 25 kW/m²	$D_s(4)$	2	3	0
	VOF_4	2	3	0
	$D_s max$	15	15	6
NF X 70-100	CIT_{NLP}	0.8	0.69	0.6
ISO4589-2	$\%O_2$	37.6	42.5	49

Fire Protection of Buses
UN ECE Regulation 118

ULTEM™ 9085 CG

ULTEM™ 9085 CG resin was printed with a T16 tip on the Stratasys F900, using single contour and +45/-45 solid rasters, which are typical default settings and tested per EN-45545-2

- Orientation: Flat XY
- Sample thickness: 3mm

Table 14. ULTEM 9085 CG Resin Fire Protection of Buses Test Results

Horizontal Burning Annex VI	Melting Behavior Annex VII	Vertical Burn Annex VIII
Passed	**Passed**	**Passed**
The tested samples do not ignite, the burning rate is 0mm/min.	No drop is formed that ignites the cotton wool during testing.	The tested samples do not ignite, the burning rate is 0mm/min.

Appendix

Figure 1. 2nd heating scan DSC data for ULTEM™ 9085 resin, natural

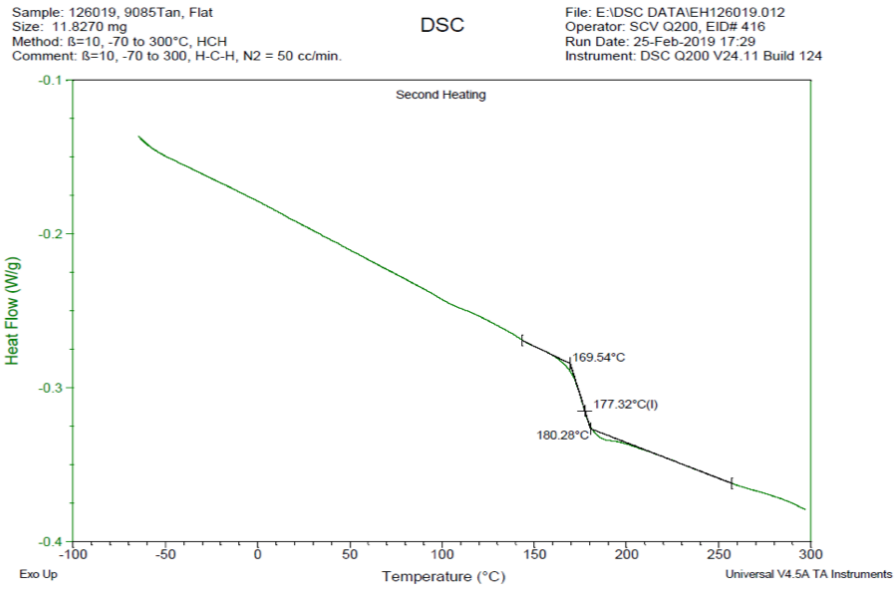


Figure 2. 2nd heating scan DSC data for ULTEM™ 9085 resin, black

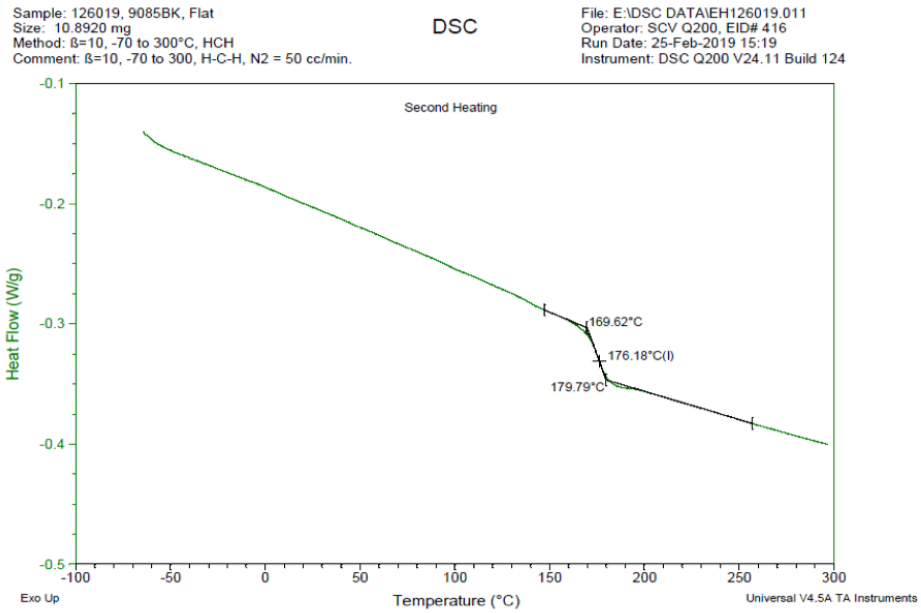


Figure 3. Dimension change data as a function of temperature for ULTEM™ 9085 resin, natural, flat (XY)

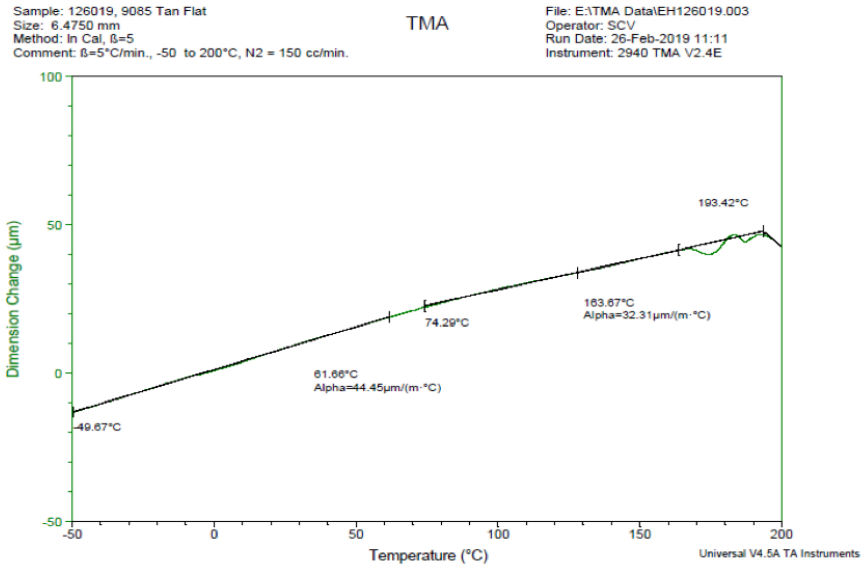


Figure 4. Dimension change data as a function of temperature for ULTEM™ 9085 resin, natural, upright (XZ)

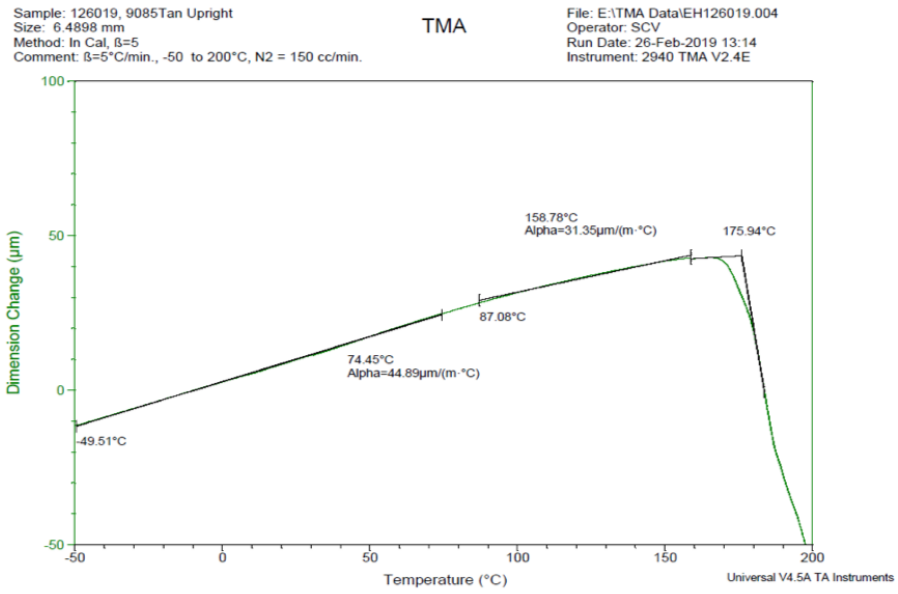


Figure 5. Dimension change data as a function of temperature for ULTEM™ 9085 resin, black, flat (XY)

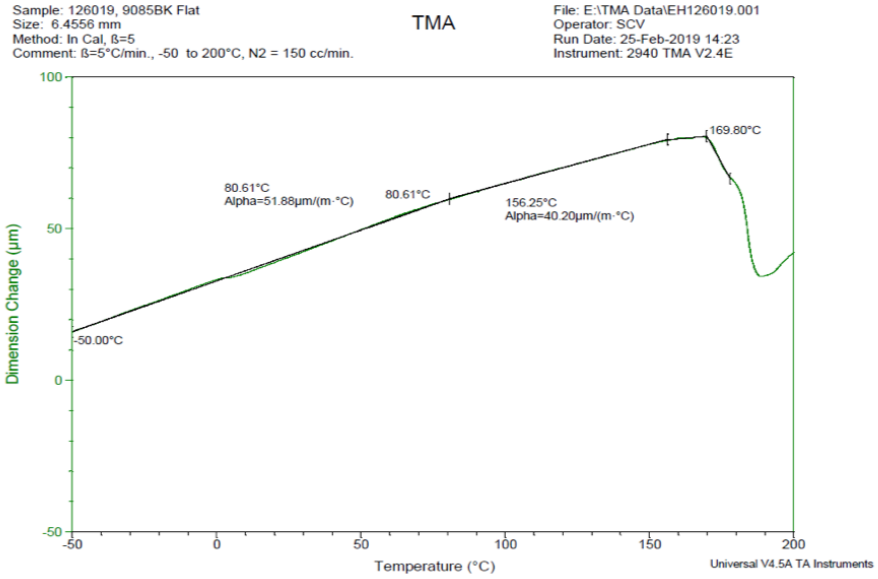


Figure 6. Dimension change data as a function of temperature for ULTEM™ 9085 resin, black, upright (XZ)

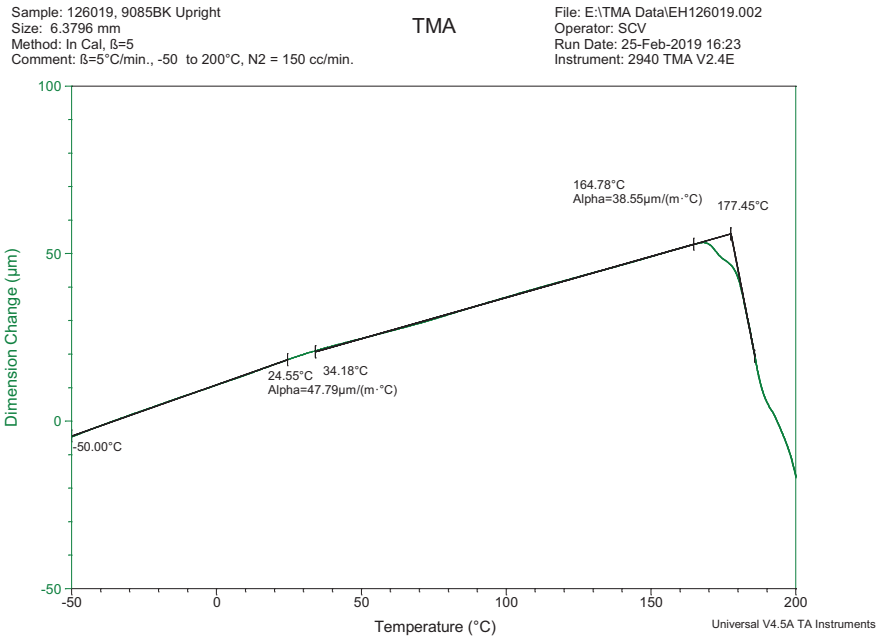
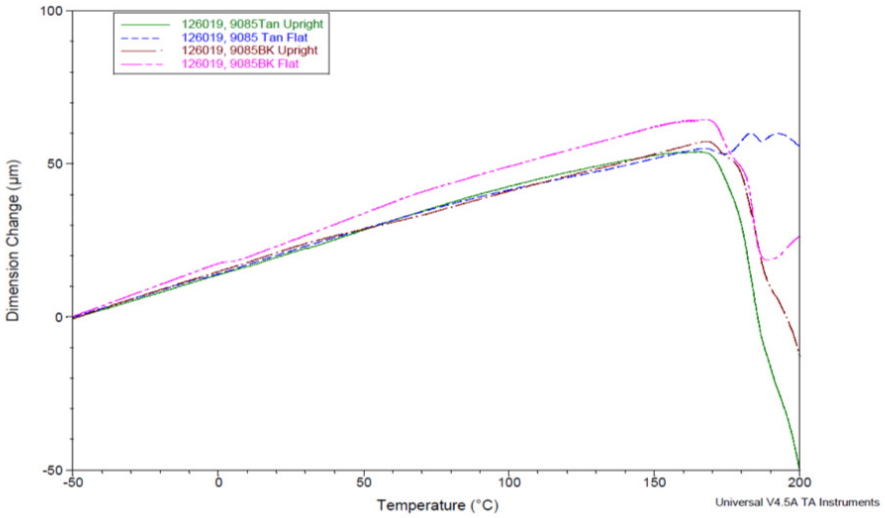


Figure 7. Overlay of the dimension change data for all the ULTEM™ 9085 resin samples



Stratasys Headquarters

7665 Commerce Way,
Eden Prairie, MN 55344
+1 800 801 6491 (US Toll Free)
+1 952 937-3000 (Intl)
+1 952 937-0070 (Fax)

1 Holtzman St., Science Park,
PO Box 2496
Rehovot 76124, Israel
+972 74 745 4000
+972 74 745 5000 (Fax)

stratasys.com
ISO 9001:2015 Certified